

INFORMATION EXTERNALITY, BANK STRUCTURE, AND GROWTH

A Dissertation

by

BO-EUN DOH

Submitted to the Office of Graduate Studies of
Texas A&M University
in partial fulfillment of the requirements for the degree of

DOCTOR OF PHILOSOPHY

December 2003

Major Subject: Economics

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ABSTRACT

Information Externality, Bank Structure, and Growth. (December 2003)

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This dissertation addresses the question of whether a monopolistic banking system can lead to a higher steady state level of capital stock. Specifically, this research analyzes the comparative advantage of a monopoly banking system. By doing that, it examines factors that contribute to the promotion of economic growth that come from a concentrated banking system.

There is substantial evidence of a positive relationship between financial markets development and long term output growth. Little is known, however, about the role played by the market structure of the banking sector on growth. Moreover, little work, if any, has attempted to analyze how the degree of information externality affects the relative performance of a monopoly and competitive banks.

I find that a monopoly banking system might perform better in accumulating capital under both low information externality and high information externality under certain conditions. In addition, this paper shows that developing countries as well as industrial countries may benefit from a concentrated banking system. This result is not found in the existing literature, which has only shown that developing countries may benefit from a monopoly banking system.

This result can be interpreted as follows: (i) for the developing countries, as the proportion of high quality firms is relatively low, the loss in output associated with lending capital to lower quality firms is relatively high. In this case, the screening technology has enough value-added to compensate for the loss in output associated with the typical rent extraction activity of the monopolist. (ii) for the industrial countries, a monopoly banking system can overcome inefficiency from free riding problem associated with the information externality.

This analysis provides an alternative explanation of the recent deregulation and resulting trends in mergers and acquisitions. This supports governments' policy changes from restricting merger and acquisition activity to allowing or even promoting merger and acquisition activity.

To my parents and my wife So-Yong

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1. INTRODUCTION

This dissertation addresses the question of whether a monopoly banking system can lead to a higher steady state level of capital stock. Specifically, this research analyzes the comparative advantage of a monopoly banking system. By doing that, it examines factors that contribute to the promotion of economic growth that comes from a concentrated banking system.

Over the past decade the banking industry has undergone many changes including more severe competition from non-bank financial institutions, recurring banking crises¹, wide-ranging financial deregulation,² and the advent and rapid growth of electronic banking³ followed by breakthrough in informational technologies.

Figure 1 shows the recent changes in economic and financial environments.

This dissertation follows the style and format of *Econometrica*.

¹ The disastrous collapse of U.S. Savings and Loans (S&Ls) in late 80s, the Chilean banking crisis in the 80s, the Argentine and Mexican crises in the mid 80s and 90s, as well as the recent turmoil in East Asia (97-98), Russia (98) and Latin America (98-02) are only a few examples. We have significant evidences that after a crisis, the market structure of the financial institutions has become considerably more concentrated. Appendix A describes how market concentration changes after crisis in Korea.

² In 1999 U.S has introduced the Gramm-Leach and Bliley Financial Service Modernization act, which replaces the Glass-Steagall Act. The Act provides more momentum for the consolidation of financial services. By eliminating the statutory barriers among the banking, insurance, investment banking, the financial institutions can offer such a diversified set of financial services as banking, investment, insurance. For the regulatory structure and history of bank regulation in U.S, see Madura (2001) pp.468-78

³ According to the Basel Committee Report of Banking Supervision (1998), electric banking refers to the provision of retail and small value banking products and services through electronic channels. Thus, in the most encompassing definition, electronic banking would run the gamut from direct deposits, ATMs, credit and debit cards, telephone banking, to electronic bill payment and web-based banking.

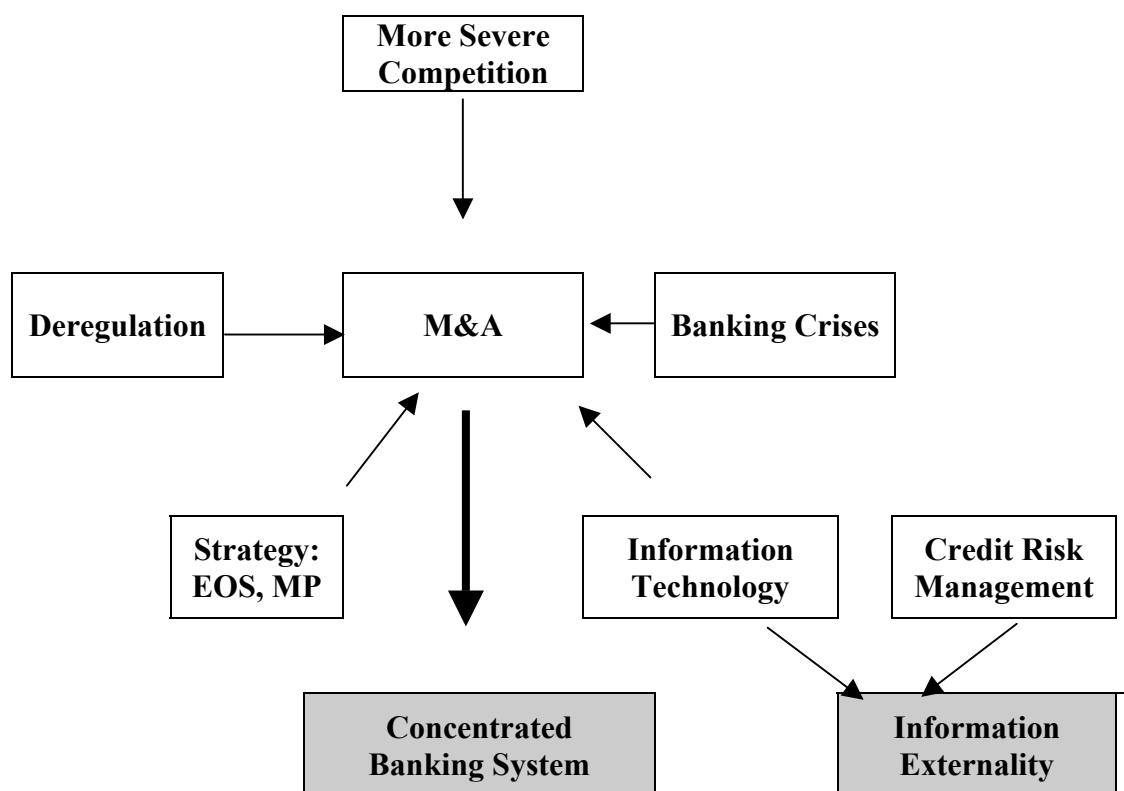


FIGURE 1.- Changes in Economic and Financial Environments

Advances in information technology make it possible that information is more rapidly transmitted among banks. The rising importance of credit risk, a major issue in the banking industry in the 1990's, has led to a move to establish an aggregate credit evaluation system which would aggregate and share credit information between banks,⁴

⁴ During 1990's, many countries have established an aggregate information system which leads to a significant information externality. Conventional wisdom suggests that in general, market equilibrium will be inefficient in the presence of externalities and also suggests that one of the solutions to externality is merger and acquisition to internalize the externality.

e.g. see Appendix A for the case of Korea. This in turn is leading to a substantial information externality⁵.

In response to environment changes and strategic considerations such as economies of scale and market power, banks have grown through the purchase and absorption (P&A) or mergers and acquisitions (M&A) of other financial institutions. As a consequence, the underlying structure of banking industry has become more concentrated. Table I shows the bank concentration ratio of major countries which is calculated by the sum of the market shares (measured by total assets) of the three largest banks.

There have been heated controversies about the advantages and disadvantages of a concentrated banking system among economists, policy makers and the general public. The issues raised include: Is this trend a right direction? Why have many countries recently deregulated to motivate M&A?⁶ Do they have reasons to rationalize policy change from anti-M&A to pro-M&A?

⁵ The information externality referred to here arises from the fact that once information on firm's credit quality is created, it can be immediately transmitted to other banks. The literature on public goods show that the free riding problem associated with such an externality leads to inefficient provision of public good. See Varian (1992). In the banking industry, the free riding problem arises when it is assumed that a bank's decision to extend or deny a loan is observable. For more details, see Cetorelli and Peretto (2000)

⁶ Deregulation for less competitive financial markets is seemingly paradoxical as one of the primary goals of deregulation has been to improve the efficiency of banks by increasing competition among them. However, bank regulators have recently admitted that concentrated banking and financial industries can help to stabilize financial systems and consequently can enhance social welfare.

There is substantial evidence of a positive relationship between financial markets developments and long term output growth.⁷ However, little is known about the role played by the market structure of the banking industry in capital accumulation and economic growth. In addition, little work, if any, has attempted to explore the policy implications of changes in banking market structure.

Although several studies have addressed the issue of whether a monopoly banking system has better performance in terms of economic growth, there have been theoretical debates over the effects of competition on capital accumulation and real economic activities.

Table I

Bank Concentration Ratio

	(%)			
	1994	1995	1996	1997
Germany	40.7	42.7	44.9	54.1
Japan	20.0	20.3	22.8	24.8
UK	54.9	52.4	45.8	52.9
US	16.0	15.9	19.9	20.0
OECD	57.0	55.6	54.8	62.3
non-OECD	64.5	61.4	61.0	67.2

Source: Worldbank Database

⁷ Schumpeter (1911), Cameron (1967), Goldsmith (1969), McKinnon (1973) and Shaw (1973) emphasize the fact that financial markets affect and are affected by economic growth. Recently, King and Levine (1993) Rajan and Zingales (1998), Beck, Levine and Loayza (2000) show that the strong, positive relationship between financial intermediary development and economic growth.

Conventional wisdom suggests that competition promotes efficiency. In this view, a monopoly bank would exercise its monopoly power to extract rents by charging higher loan rates and/or by paying lower deposit rates. The resulting decreased supply of funds and the associated higher lending rates would lead to a slower process of capital accumulation. Smith (1998) and Guzman (2000b) provide support for this conventional wisdom by showing that a competitive banking system performs better in accumulating capital stock.

However, some argue that the literature on efficiency in banking does not consider how the banking industry differs from other industries⁸. For example, Allen and Gale (2000) argue that the standard competitive paradigm is not appropriate for the banking industry. Unlike the assumptions of the conventional wisdom, neither markets nor information tends to be complete in the banking industry. One of the crucial limits of the conventional wisdom is that it is not consistent with historical evidence⁹. Petersen and Rajan (1995), Caminal and Matutes (1997) and Schnitzer (1998) show that a monopoly banking system performs better with respect to promoting economic growth. They show that a monopoly bank can more easily overcome the problem of asymmetric information by close ties with firms.¹⁰ A monopoly bank also benefits from choosing the most

⁸ See Berger and Mester (1997) for the survey of the literature.

⁹ See Gerschenkron (1965), Cohen (1967) and Sylla (1969). Cetorelli and Gambera (2001) summarize the effect of concentrated credit market on economic development and industrialization.

¹⁰ In addition, as seen in Petersen and Rajan (1995), firms with lower credit quality such as new firms and small firms are able to obtain fund more easily as the number of banks is reduced, since banks then have a higher probability of sharing the potential future profits of firms. In this view, the loss from extracting rent

profitable projects (by reducing adverse selection) and making firms use funds in less risky projects (by preventing moral hazard).

The contradictory results listed above are mainly due to different views of the banking business. When we focus on the transactional function of banks, a more competitive system has better performance, but when we focus on relationship banking, a less competitive system has better performance in promoting economic growth.¹¹

The studies focus on the asymmetric information structure between banks and firms. However, little, if any, work has attempted to explore the effect of the information externality¹² on relative performance between a monopoly and a competitive banking system. Much of the literature on public goods argues that in general an externality leads to inefficient provision of the public good. If there is an information externality, a competitive equilibrium may not Pareto dominate. In other words, the superiority of the competitive paradigm depends on other features such as the degree of information externality and, for the case investigated here, the elasticity of capital demand and the proportion of high quality firms.

This paper shows that the presence of an information externality together with asymmetric information can explain how an economy with a monopoly bank might have a higher steady state level of capital stock than an economy with a competitive banking

is compensated by the gain from overcoming the problems associated with asymmetric information and from increased lending to small and new firms.

¹¹ See Boot and Schmeits (1998) for the difference between transaction-oriented and relationship-oriented banking businesses.

¹² Information externality refers to the fact that once information on firm's credit quality is created, it can be immediately transmitted to other banks.

system. The presence of investment technologies subject to costly state verification is essential to understand how a monopoly bank performs better compared to a competitive bank. I assume that the state verification of investment projects (hereafter, I will state it as screening activities) is economically meaningful. That is, I assume that the benefits of screening activities exceed the cost.

This paper shows that the optimal strategies for competitive banks are dependent upon the degree of the information externality. For example, competitive banks do not engage in screening activities in the case of a high degree of information externality, while they do engage in screening if there is a low degree of information externality.

The optimal strategy for duopoly banks is the same as that of competitive banks if there is no commitment each other to choose a certain strategy, the optimal strategy for duopoly banks is “no screening” in the case of a high degree of information externality, while “screening” in the case of low degree of information externality. Hence, the duopoly model with no commitment will have same result as the competition model.

Unlike both competitive banks and oligopoly banks, the best strategy for a monopoly bank is to screen regardless of the degree of information externality. Hence, in the case of high degree of information externality, a competitive banking system and duopoly banking system may have negative repercussions for capital accumulation, as benefits from screening are greater than screening costs.

This paper extends the Cetorelli's (1997) and Bernanke and Gertler (1989) framework by incorporating several features relevant to the current economic environment. This research is more comprehensive than previous work because it

compares the behavior of competitive, monopoly and duopoly banks. In addition, a novelty of this research is that the model allows various degrees of the information externality, and information is treated as both private and public, depending on the degree of the information externality. If there is perfect information externality, then information obtained by a bank is a public good in the sense that once one bank acquires information other banks know the information immediately and without cost. In contrast, if there is no information externality, then information on a firm's quality is private information in the sense that it is owned and used exclusively by the information-acquiring bank. Finally, I incorporate an indicator for the degree of financial market development, and an explicit the elasticity of capital demand.

The major finding of this paper is that a monopoly banking system might lead to better performance in accumulating capital under both a low and a high degree of information externality. This is opposite to the conventional wisdom, see e.g. Cetorelli's (1997)¹³. A monopoly bank benefits from the allocative efficiency associated with screening activities (specifically, screening activities are closely related to the relationship between banks and firms) and the absence of a free riding problem associated with the information externality. A monopoly bank can easily overcome the problem of asymmetric information by close ties with firms.¹⁴ But it also can overcome

¹³ He finds that the competitive banking system usually has better performance. However if the proportion of high quality firms is low, then the monopoly banking system may have better performance. This suggests a positive role for a monopoly bank and it may be true especially for developing countries.

¹⁴ In addition, as seen in Petersen and Rajan, firms with lower credit quality are able to obtain funding as the number of banks becomes less, since banks can share the potential future profit of firm. In this view,

the free rider problem associated with the information externality by making investment on information technology at an efficient level. See e.g. Petersen and Rajan (1995), Caminal and Manués (1997) and Schnitzer (1998)

In addition, this paper shows that a monopoly banking system is more likely to achieve a higher level of steady-state capital as the degree of information externality increases. It also shows that (i) a monopoly banking system has a higher steady state level of capital as financial markets advance, and (ii) the negative repercussion of capital formation, associated with rent extraction activity in the monopoly banking system, becomes worse as an economy has higher elasticity of capital demand. Hence, for the industrial countries having highly developed financial markets, a high elasticity of capital demand, and a high degree of information externality, the net effect of a concentrated banking system is ambiguous.

This research suggests that developing countries as well as industrial countries may benefit from a concentrated banking system. This result is not found in the existing literature, which has only shown that only developing countries may benefit from a concentrated banking system.¹⁵

This can be interpreted as follows: (i) for the developing countries, as the proportion of high quality firms is relatively low, the loss in output associated with lending capital

the loss from extracting rent is compensated by the gain from overcoming the problems associated with asymmetric information and from increasing loan amount to small and new firms.

¹⁵ Cetorelli (1997) finds that the beneficial effect of a monopoly bank would be maximized when the proportion of high quality firm is low. This condition suggests that a monopoly banking system is beneficial to growth for developing countries.

to lower quality firms would be relatively high. In this case, the screening technology has enough value-added to compensate for the loss in output associated with the typical rent extraction activity of the monopolist; (ii) for the industrial countries, a monopoly banking system can overcome the inefficiency associated with the free riding problem that arises from the information externality.

This analysis provides an alternative explanation of the recent deregulation and resulting trends in mergers and acquisitions, as well as an explanation for the apparent government policy changes from anti-M&A to pro M&A.

The remainder of the paper proceeds as follows. Section 2 reviews the relevant literature. In Section 3, the model and its relevant factors are described. Section 4 analyzes the effect of bank structure on the lending strategy and derives equilibrium in each banking system. In Section 5, the long run equilibrium of capital, which is unique, is compared among each banking system. Section 6 discusses policy implications and in Section 7, the conclusion is presented.

2. LITERATURE SURVEY

This section reviews five strands of issues on intermediation theory, financial markets and growth. Section 1 describes the intermediation theory, focusing mainly on the bank's role to overcome the basic problem of asymmetric information. Section 2 summarizes the current discussions about the effects of financial market in general and bank in particular on the economy. Section 3 explains two distinct financial structures i.e. bank-based and market-based financial system. In Section 4, the models will be classified into relationship-oriented and transaction-oriented models. Lastly, Section 5 discusses the advantages and disadvantages of concentrated banking structure.

2.1. Intermediation Theory and Banking Business

In the traditional Arrow-Debreu model of resources allocation, financial intermediaries play no role as firms and households interact through markets. When markets are perfect and complete, the allocation of resources is Pareto-efficient. Therefore, there is no scope for intermediaries to improve welfare. Moreover, the Modigliani-Miller theorem claims that the financial structure of firms does not affect the value of firms. In other words, the debt-equity composition of firms' financial status has no effect on the value of the firms. Households can construct portfolios which offset any position taken by an intermediary, therefore, intermediation cannot create value.¹⁶

¹⁶ See the Allen, Gersbach, and Santomero (2001) pp.271-294

Such an extreme view is clearly at odds with what is observed in reality. Historical evidence shows that banks have played a central role to improve the economy. Banks have transformed savings from the household sector into investments in real assets. They select the investment project to be funded and provide incentives for the monitoring. Banks may ease risk sharing and pooling by lowering transaction costs and facilitate saving's mobility by economizing on the transaction costs associating with mobilizing savings from many different agents and by overcoming the informational asymmetries associated with making savers comfortable in relinquishing control of their savings.¹⁷

Townsend (1979) and Stiglitz and Weiss (1981) develop some of the banking related models based on utility and profit maximization. Their models focus primarily on the effect of asymmetric information on the allocation of resources. Followed by these researches, Diamond (1984) develops a theoretical framework that models financial intermediaries more explicitly. In the model, banks arise naturally as a means for overcoming asymmetric information problem and possess economies of scale¹⁸ with respect to gathering information and monitoring firms, and thus are more efficient than individual investors could be.

¹⁷ For the details, see Levine (2002)

¹⁸ Economies of scale in monitoring loans give bank loans another advantage over bilateral lender contracts. Such economies are another reason why in theoretical model bank exists in equilibrium.

2.2. Financial Markets and Economic Growth

Pioneered by Schumpeter (1911), economists argue that financial intermediation influences the real economy by accumulating capital stock. They show that the financial sector could impact real economic performance by affecting the composition of savings, providing information and affecting the scope for credit rationing.¹⁹

Among early works on this issue, Cameron (1967), Goldsmith (1969), McKinnon (1973) and Shaw (1973) emphasize that the financial markets affect and are affected by economic growth.²⁰ They suggest that well-developed financial markets are prerequisite for developing countries to accomplish the overall economic enhancement.

There has recently been lots of empirical studies that explore the relationship between financial market development and growth. They also show a strong and positive relationship between the development of financial sector and the real economy. King and Levine (1993) show that the level of financial intermediary development is a good predictor of economic growth. Subsequent studies refine King and Levine and establish that financial markets are a source of economic growth.²¹

The studies using time-series data also support that growth can be predicted by the degree of the financial market development. Neusser and Kugler (1998), Rousseau and

¹⁹ Gertler (1988) discusses about allocating effects of information problem in financial markets.

²⁰ For a more detailed overview of this work, see the Gertler (1988)

²¹ See Atje and Jovanovic (1993), Demirguc-Kunt, Levine (2001), Levine and Zervos (1998), and Levine (2002). They have refined King and Levine's results by showing growth rates in developed countries differ from that in and less developed countries as financial markets in developed countries are established and mature.

Wachtel (1998) show that financial developments are essential for economic growth.

In addition, some studies analyze industry-level, firm-level data and event-study. Rajan and Zingales (1998) and Demirguc-Kunt and Maksimovic (1998) also support that the level of financial development has large, causal²² impact on real per capita GDP growth. Beck, Levine and Loayza (2000) find that the strong, positive relationship between the financial intermediary development and long-run economic growth.

2.3. Financial Market Structures: Bank-based vs. Market-based

This section reviews the distinction of financial markets structure – i.e. bank-based and market-based financial system. Table II shows the classification of countries in terms of bank-based and market-based. The German model of financial intermediation by universal banks is usually considered the prototype of bank-based financial system.²³

In bank-based financial systems such as Germany, Japan and most Western European countries, banks play a leading role in mobilizing savings, allocating capital, overseeing the investment decisions of corporate managers and providing risk management tools.

Contrarily, in market-based financial system such as the United Kingdom and the United States, securities markets share center stage with banks in terms of getting the society's saving to firms, exerting corporate control, and easing risk management. The

²² The causality issue that financial development leads to economic growth is somewhat controversial. The empirical results of the direction of causality varies country by country. See Shan, Morris and Sun (2001).

²³ For the details, see Levine (2002)

Table II
Country Classification

	High Income (28)	Low Income (30)
Market Based (20)	Australia, Canada, Denmark, Korea, Netherlands, Spain, Sweden, Switzerland, Taiwan, United Kingdom United States (11)	<i>Brazil, Chile, Jamaica, Malaysia, Mexico, Peru, Philippines, South Africa, Thailand (9)</i>
Bank Based (29)	<i>Argentina, Austria, Belgium, Cyprus, Finland, France, Germany, Greece, Ireland, Israel, Italy, Japan, New Zealand, Norway, Portugal, Venezuela (16)</i>	<i>Bangladesh, Columbia, Costa Rica, Ecuador, Honduras, India, Kenya, Mauritius, Nepal, Pakistan, Panama, Sri Lanka, Zimbabwe (13)</i>
Others (9)	<i>Malta (1)</i>	<i>Bolivia, Dominican Republic, El Salvador, Ghana, Guatemala, Nigeria, Paraguay, Uruguay (8)</i>

Note: Parenthesis denotes the number of countries.

The countries whose real per GDP is greater than US\$2,975 are classified as high income country and less than US\$2,975 as low income country.

Bold represents countries with a well-developed financial market, while italic represents countries with under-developed financial market

Source: Demircuc-Kunt and Levine (2001), Worldbank Database

most fundamental difference between these two systems is that non-financial enterprises in a bank-based system are more dependent upon bank-intermediate financing than their counterparts in a market-based system.

The proponents of bank-based financial systems argue that bank-intermediated financing is preferable to other forms of financing because of the potential ability of banks to overcome the problems of asymmetric information and moral hazard. Universal banks are not only specialized in screening and evolutionary loan proposal, but they also rely on economies of scope arising from their involvement with the loan applicant in

other lines of business. According to the bank-based view, bank-based financial systems are more effective than market-based financial systems for the promotion of the economic growth, especially in countries at early stages of economic development.

The proponents of the market-based financial system stress the importance of well-functioning securities markets in providing incentives for investors to acquire information, impose corporate control, and design financial arrangements. According to the market-based view, market-based financial systems are better for promoting long-run economic growth than bank-based financial system.

From the differences in the relative performance of the Japanese and U.S. economies over the past few decades, many economists have reached a conclusion that bank-based and market-based financial systems may provide different growth patterns. Demirguc-Kunt and Levine (2001) provide evidence on the legal, tax and policy determinants of financial structure.²⁴ Levine (2002) also tests whether bank-based or market-based models have the comparative advantages to promote growth. He finds that the difference in financial system does not explain cross-country differences in the long-run economic performance.

²⁴Allen and Gale (2000) analyze the relative benefits of market-based and bank-based financial system

2.4. Relationship Oriented vs. Transaction Oriented ²⁵

The traditional relationship-oriented banking, based on spread between loan and deposit rates has declined dramatically²⁶ as firms increasingly seek funding from financial markets as the financial innovations such as securitization, derivatives and underwriting has greatly progressed. However, in traditional relationship oriented banking business, banks hold non-marketable and illiquid assets. The banks' assets are illiquid largely because of their information sensitivity. In originating and pricing loans, banks develop proprietary information. Subsequent monitoring of borrowers yields additional private information. The proprietary information prohibits the marketability of these loans. In these situations, the access to information is the key to understand the comparative advantage of banks. In many of their activities, banks use their own information and the related network of contacts. The relationship oriented banking is a characteristic of value enhancing financial intermediation.

Regardless of changes in economic environment such as the breakthrough in information technology and the advance in financial innovations, bank loans may continue to be optimal instruments.²⁷ Bank-borrower relationship is in nature a mutual commitment based on trust and respect. This allows for implicit long term contracts.

²⁵ This section summarized the paper by Boot and Schmeits (1998)

²⁶ For details, see Edward and Mishkin (1995)

²⁷ Bank loans are generally easier to renegotiate than bond issues or other capital market funding. The renegotiation allows for a qualitative use of flexibility. Firms may realize that they can renegotiate ex post. Therefore granting priority to bank loans may help firms with priority, banks may strengthen its bargaining position and thus become tougher.

Information asymmetries in the financial markets and non-contractibility of various pieces of information would rule out long-term alternative capital market funding sources as well as explicit long term commitments by banks. Therefore, both bank and firm realize the added value of their relationship, and will seek to foster their relationship.^{28 29}

An investment bank is generally considered as an example of transaction oriented banking. Investment banks facilitate transaction as brokers and underwrite public placements. By underwriting new issues, investment banks process and absorb credit and placement risk, which is similar to that encountered in traditional bank lending. Underwriting also requires information acquisition about borrower.

Many studies analyze the macroeconomic difference between two banking systems, monopoly and perfect competition. Some show that a monopolistic banking system has better performance in promoting growth, while others show that a competitive banking system performs better. Petersen and Rajan (1995), Caminal and Matutes (1997) and Schnitzer (1998) emphasize relationships between banks and firms. They focus on long-term relationship between banks and firms and claim that the firm facing a monopoly credit market is more likely to form a strong tie with the bank. A monopoly bank, hence,

²⁸ Mayer (1988) and Hellwig (1991) discuss the commitment nature of bank funding. Boot, Thakor and Udell (1991) address the credibility of commitments. Schmeits (1997) formally considers the impacts of discretion (flexibility) in bank loan contracts on investment efficiency.

²⁹ Bank loans are generally easier to renegotiate than bond issues or other capital market funding. The renegotiation allows for a qualitative use of flexibility. Firms may realize that they can renegotiate ex post. Therefore granting priority to bank loans may help firms. With priority, banks may strengthen its bargaining position and thus become tougher.

easily eliminates the problem of asymmetric information. The monopoly bank benefits from choosing the most profitable firms or projects (by eliminating adverse selection) and making firms to use funds in less risky way (by preventing moral hazard). In addition, as seen in Petersen and Rajan, as market power increases, firms with lower credit quality are able to obtain funding since banks can share the potential future profit. In this view, the loss from extracting rent is overwhelmed by the gain from overcoming the problems associated with asymmetric information and increasing loan amount to small and new firms. Therefore, they conclude that monopolistic banking system is better to promote GDP growth.

Contrary to a relationship-oriented model, Cetorelli (1997), Smith (1998) and Guzman (2000b) emphasize the transactional function of banking business and find that less competitive system may be detrimental to the economy. As advances in financial innovations, securitizations and underwriting push funding to the financial markets, banks should focus on transactional function. In this view, a big bank, resulting from M&A may lose transparency and therefore reduce the effectiveness of market discipline. Thus, more competition can lead to higher efficiency in the economy. This result is consistent with conventional wisdom.

These contradicting results come from different views of banking business. Unlike many businesses, banks do not produce physical goods, but rather, provide the financial means for production. One of the biggest problems faced by the banking sector is the lack of information about the quality of firms and of the project they have. This

asymmetric information leads to problem of adverse selection and moral hazard. These inherent problems can be eliminated more easily by a monopolistic banking system.

2.5. Bank Structure and Economic Development

Conventional wisdom asserts that a monopoly tends to reduce an economy's overall social welfare. Monopoly charges higher prices and produces less goods and services. They suffocate invention and innovation, and distort resource allocation, all of which reduce the capital stock and growth. These negative aspects of a monopoly might be applied to the banking sector. We might predict, hence, that a monopoly bank makes fewer loans and has higher interest rates on loans and lower interest rates on deposits than a competitive bank. Guzman (2000b) finds that a monopoly bank tends to depress the equilibrium law of motion for the capital stock, thus, reduces the level of long run real activity. He also explains the process by which a monopolistic banking system depresses capital stock as follows: a monopoly bank is more likely to lead to credit rationing, and if there is a credit rationing, interest rates paid on deposits will be lower under a monopolistic banking system. If there is no credit rationing under a monopoly bank, the interest rate charged on loans will be higher, but the deposit interest rate is the same under the two systems.

Regardless of the negative effects of a monopoly, it is possible to find historical evidence correlated with the positive role of concentrated credit markets for the economic development. Cetorelli and Gambera (2001) find the following mechanism:

concentration of market power in banking facilitates the development of lending relations, which have in turn an enhancing effect on firms' growth and, thus on the potential productivity of whole economy.

Most of the theoretical literature on the relationship between intermediation and growth considers an economy with a competitive banking system. But in practice, economies vary in the competitive environment of their banking systems. Table III shows an approximate measure for the degree of competition within various countries banking sector.

Table III
List of Countries and Bank Concentration Ratio

	Bank Concentration	Country Name	Bank Concentration
Argentina	0.5045	Korea, Republic of	0.3126
Australia	0.6482	Malaysia	0.4888
Austria	0.7219	Malta	0.9554
Bangladesh	0.6439	Mauritius	0.9434
Belgium	0.6477	Mexico	0.5836
Bolivia	0.4810	Nepal	0.9018
Brazil	0.6006	Netherlands	0.7378
Canada	0.5838	New Zealand	0.6940
Chile	0.4676	Niger	0.8051
Colombia	0.4364	Norway	0.8398
Costa Rica	0.7862	Pakistan	0.7413
Cyprus	0.8757	Panama	0.4196
Denmark	0.7438	Paraguay	0.5792
Dominican Republic	0.6510	Peru	0.6887
Ecuador	0.3971	Philippines	0.4638
El Salvador	0.8442	Portugal	0.4578
Finland	0.8828	South Africa	0.7677
France	0.4144	Spain	0.4738
Germany	0.4550	Sri Lanka	0.8187
Ghana	0.8874	Sweden	0.8831
Greece	0.7693	Switzerland	0.7591
Guatemala	0.3735	Taiwan, China	0.4194
India	0.4727	Thailand	0.5289
Ireland	0.7350	United Kingdom	0.5565
Israel	0.8421	United States	0.1865
Italy	0.3563	Uruguay	0.8718
Jamaica	0.8226	Venezuela	0.5233
Japan	0.2170	Zimbabwe	0.8213
Kenya	0.7393		
<ul style="list-style-type: none"> The values reported are averaged over 1990 to 1997 and calculated by the sum of the market shares(measured in total assets) of the three largest banks. 			

Source: Worldbank Database

3. THE MODEL

3.1. Overlapping Generations Model

This paper employs a standard two-period lived, overlapping generations model with production.³⁰ Population is assumed to be constant and each generation is composed of a continuum of agents with unit mass.³¹ Time is discrete, and indexed by $t = 0, 1, 2, \dots$

Every period, there are two generations (the young and the old) and a single good is produced. Young agents are endowed with one unit of labor, which is supplied inelastically at the real wage w_t , and endowed with one indivisible investment project. The size of the investment project is assumed to be identical across firms.

Each generation is divided into two types, depending on the quality of their endowed investment project, which we label Type 1 (the High-Quality Project) and Type 2 (the Low-Quality Project). Type 1 young agents (those with Type 1 projects) comprise a fraction $\Phi \in (0,1)$ of the population, while Type 2 young agents (those with Type 2 projects) comprise a fraction $(1 - \Phi)$ of the population.

Both Type 1 and Type 2 young agents are identical with respect to their preferences. They prefer operating their own business to working as employee. They derive utility

³⁰ The overlapping generations model has the advantage of providing a tractable framework for dynamic general equilibrium analysis, into which heterogeneity among borrowers and lenders is easily incorporated. See Bernanke and Gertler (1989)

³¹ As there is no distinction between aggregate and per worker variables under a unit mass assumption, a unit mass of workers implies that we will generally have to handle in per capita rather than aggregate basis.

from consuming the final good both when young and when old. Agents are assumed to care only about their lifetime consumption. They have a constant relative risk aversion (CRRA)³² utility function.

Young agents are potential firms. They have access to a production technology which has a two-stage process as in Cetorelli (1997); investment and production. However, they have no endowment of capital or goods.

Old agents have no endowment of either labor or goods, and they have no access to the investment project. They have saving from the previous period in the form of deposits and equity capital of banks.³³ At the end of the period, the old consume all they have before dying. It is also assumed that the initial old generations have an aggregate endowment of final goods, $K_0 > 0$, distributed equally among all of them

Banks are institutions owned by old agents as in Cetorelli and Peretto (2000). They intermediate resources between old agents born at $t-1$ and young agents born at t at the beginning of time t . At the end of time t , banks recover loans from successful young

³² Given a twice differentiable Bernoulli utility function $u(\cdot)$, the coefficient of relative risk aversion at c is $r_r(c, u) = -cu''(c)/u'(c)$. Models with CRRA are encountered often in finance theory, where they lead to considerable analytical simplicity. That is, no matter how the wealth of the economy and its distribution across individuals evolves over time, the consumption and saving decisions of individuals do not vary as long as the interest rate on deposits remain same. See Mas-Colell, Whinston and Green (1995) p.194

³³ A standard arbitrage argument requires for an interior solution that the rate of return to deposits be equal to the rate of return to equity. I will show this later.

agents and pay principal and interest back to old agents. Banks can make profits³⁴, which are thus part of the resources that old agents use to finance consumption.

3.2. Two Stage Production Function

Production is assumed to be a two-stage process in each period; investment and production. In the investment stage, a firm makes an investment to produce physical capital. The investment project is such that it transforms one unit of goods at the beginning of period t into one unit of capital at the end of period t . The outcome of this set-up stage is either success or failure.

If investment turns out to be successful, a firm can transform one unit of the final good into one unit of capital. If investment is unsuccessful, the resources used in investment are assumed to be completely lost and a firm will default as in Azariadis (1993).³⁵ Figure 2 shows the production process.

The young agents with the high quality project (or Type 1 young agents) who obtained physical capital in the investment stage have access to the production stage. In the production stage, a single final good is produced by using physical capital and labor. K units of physical capital and $(1+L)$ units of labor produce $F(K, 1+L)$ units of the final

³⁴ This paper compares the relative performance of competitive banks and a monopoly bank. It is generally assumed that a competitive bank has zero profits, while a monopoly bank can make positive profits.

³⁵ This does not affect the results. The advantage of this simplification is that it makes the production stage free of any source of uncertainty.

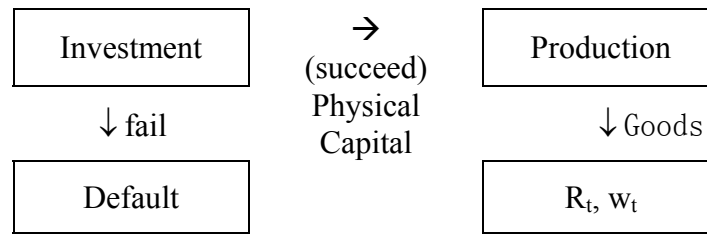


FIGURE 2. – Production Process

good, where $F(\bullet)$ is a constant returns to scale³⁶ production function. Recall that it is assumed that labor supplies are fixed.³⁷

Let $f(k) = F(k, 1)$ denote a standard neoclassical intensive production function, where $k_t = K_t / (1 + L_t)$ is the capital-labor ratio. K_t is aggregate stock of physical capital, which is equivalent to successful investment, according to the assumption of one to one transformation in the investment stage. The size of loans will be determined by the firm's profit maximizing problem. A high quality firm's loan contract to banks and its profit maximizing problem will be analyzed at the next section. Labor market clearing at time t requires

$$(1) \quad L_t = (1 - \Phi) / \Phi$$

³⁶ Obviously, mergers between banks might lead to economies of scale. To concentrate this study on the “market power”, however, I assume constant returns to scale.

³⁷ I focus on explaining investment fluctuations rather than employment fluctuation as in Bernanke and Gertler (1989). Extensions of the results to the various employment cases are straight forward in principle.

since the total labor demand from high quality firms at t is ΦL_t , while the total supply of labor from low quality firms is $(1 - \Phi)$.

Hence, a high quality firm's capital-labor ratio is given by

$$(2) \quad k_t = K_t / (1 + L_t) = \Phi K_t$$

It is assumed that $f(k)$ is a smooth, increasing, and strictly concave function with $f(0) = 0$, i.e. $f_k > 0$, $f_{kk} < 0$ and Inada conditions³⁸ hold. To fix ideas, I will use a Cobb-Douglas production function:

$$(3) \quad y_t = f(k_t) \equiv k_t^\gamma, \quad 0 < \gamma < 1$$

where y_t and k_t are production per capita³⁹ and capital per capita at time t , respectively.

3.3. Nature of Uncertainty

There are two approaches to model the nature of uncertainty. We can have homogeneous agents with different quality of their endowed investment projects, or we can have heterogeneous agents. In both cases, it is assumed that banks ex ante do not know the quality (or Type) of investment (i.e., the agent type), however they have a screening technology which makes it possible to distinguish high quality from low quality investments by paying a screening cost. In this economy, then, banks play two

³⁸ These conditions state that $\lim_{k \rightarrow 0} f'(k) = \infty$, $\lim_{k \rightarrow \infty} f'(k) = 0$. Actually, they help to ensure the existence of a nontrivial steady state.

³⁹ Throughout the paper, “per capita” means “per member of a given generation”.

important roles as in Diamond (1984). First, they collect savings and give credit to firms, thus achieving diversification of idiosyncratic risk. Second, banks possess economies of scale with respect to gathering information and monitoring firms.

3.3.1. Homogeneous Agents

In this model economy, agents are homogeneous, i.e. ex ante identical. They have no knowledge of the quality of the investment project they possess. The outcome of investment follows a random process⁴⁰. Banks also do not know the quality of investment, ex ante. However, banks have access to a screening technology⁴¹ which can distinguish high quality from low quality projects. Hence banks ex post have more information on the quality of investment than firms. This approach assumes a sort of reverse asymmetric information problem from that usually assumed between firms and banks in that banks have the potential to have more information than firms.

Suppose there are two levels of technology; the restaurant industry and the computer industry, and two regions, A and B. Banks can engage in screening activities to find out successful firms. Specifically, banks can access information on which technology has a comparative advantage in a particular region. Suppose the computer industry (or alternatively, the restaurant industry) has a comparative advantage at region A (or B).

⁴⁰ Investment projects undertaken in a given period have mutually independent outcomes so that there is no aggregate uncertainty about the quantity of physical capital produced. That is, expected and actual capital per capita are the same.

⁴¹ The screening activities consist of three functions: consulting, monitoring (ex ante) and auditing (ex post).

The probability of success for an entry in the restaurant industry is 100 percent in region A and zero in region B, and vice versa for the computer industry.

Suppose also that the proportion of Φ to the total population adopts the right strategy mix of technology and region, while the proportion of $(1 - \Phi)$ adopts the wrong strategy mix of technology and region. Agents are assumed to be randomly allocated in each cell of technology and region. Hence, the proportion of Φ to the total population will succeed in investment, while the proportion of $(1 - \Phi)$ will fail in the investment. Table IV summarizes the strategic mix of technology and region. Banks do not know which industry is good for a particular region, ex ante. However, bank can access the perfect information by analyzing the characteristics of an industry and those of a region.

In this case, banks have the potential to have more information than firms, as mentioned. In the real world, we can find that banks provide a consulting to firms whether or not to invest a project. The consulting business of banks is a typical example of a sort of reverse asymmetric information problem between banks and firms.

Table IV

Strategic Mix Between Technology and Region

		Region	
		A	B
Technology	T-1 (Restaurant)	Success	Failure
	T-2 (Computer)	Failure	Success

3.3.2. Heterogeneous Agents

In this alternative model economy, each generation is divided into two types, Type 1 and Type 2. Agents know their own types, *ex ante*, while banks do not. In particular, agents know their type before they borrow. Hence, this approach adopts the standard asymmetric information problem between firms and banks in that firms have more information than banks when a firm submits a loan application.

Type 1 agents comprise a fraction of $\Phi \in (0,1)$, while Type 2 agents comprise a fraction of $(1 - \Phi)$ of the population. Type 1 agents will have a lower cost of investment (or higher productivity), while Type 2 agents will have a higher cost of investment (or lower productivity). All young agents have identical preferences in that they prefer operating their own business to working as an employee.

Type 1 young agents are successful in the investment with probability of $p_H \in [0,1]$ and unsuccessful with probability of $(1 - p_H)$, while young Type 2 agents are successful with probability of $p_L \in [0,1]$ and unsuccessful with probability $(1 - p_L)$. Recall that Type 1 agents always succeed in the investment, while Type 2 agents are doomed to fail, so $p_H = 1$ and $p_L = 0$.

Table V summarizes the main features of both approaches, as mentioned. The steady state level of capital may be different between homogeneous agent case and heterogeneous case. However, either approach does not affect the quality of result. I will discuss it later.

Table V
Comparison of Both Approaches

Agent	Homogeneous	Heterogeneous
Uncertainty	Quality of Investment Project	Agents' Type
Agents' Recognition of Outcome	Unknown	Known
Banks	Unknown outcomes, ex ante. Screening Technology	
Production	Two-Stage: Investment, Production	
Asymmetric Information Problem	Ex ante: No Ex post: Yes (Reverse)	Ex ante: Yes (Normal) Ex Post: No

3.4. Sequence of Events

This section summarizes the timing of events to clarify the activities of each agent. Table VI shows the timing and activities of each agent and bank. It is assumed that every period there are two distinctive subperiods, one at the beginning of period and the other at the end of the period. The savings of old agents, funding and investment of young agents are assumed to take place at the beginning of the period. Production and income generation by young agents and consumption of both young and old occur at the end of the period.

At the beginning of time t , young generations born at time t borrow and engage in the set-up stage to produce capital. If it is successful, the capital stock is obtained. If it is

not, the firm fails to survive and the firm's owner becomes a worker. Old generations born at time $t-1$ save in the form of deposits and equity capital at this time.

At the end of time t , young agents produce final goods using capital and labor and earn an income which is either rent or wage. In addition, they make a decision on lifetime consumption, depending on their preferences. Old agents receive the principal and interest of their savings and consume the final goods.

Banks are institutions owned by old agents. Banks intermediate between the old born at $t-1$ and the young born at t at the beginning of time t . At the end of time t , banks recover loans from successful young generations and repay savings to old generations.

Table VI
Sequence of Events

		OLD ($t-1$)	YOUNG (t)	BANK
Time t	Beginning	<ul style="list-style-type: none"> . Deposit D_t . Buy Equity E_t 	<ul style="list-style-type: none"> . Borrow money . Investment <ul style="list-style-type: none"> - Capital Stock if successful - Nothing if Unsuccessful 	<ul style="list-style-type: none"> . Intermediate between old and young agents
	Ending	<ul style="list-style-type: none"> . Withdraw Saving & Interest . Consumption 	<ul style="list-style-type: none"> . Production <ul style="list-style-type: none"> - Final Goods . Earn rent or wage . Pay back loans . Consumption & Saving 	<ul style="list-style-type: none"> . Recover loans . Pay back to old agents

Parenthesis denotes the time at which each generation is born.

3.5. Credit Market

It is assumed that credit is fully intermediated. Banks intermediate between savers (the old) and borrowers (the young). The intermediation may be taken by monopoly ($N=1$), duopoly ($N=2$) or competitive banks (N is sufficiently large). It is assumed that there is no government or central bank, that banks in aggregate have access to a quantity of capital which is exactly the same amount as the old generation's saving. In addition, banks are assumed to lend the maximum available funds to potential firms. This implies that the credit market always clears at an equilibrium interest rates on loans.

The loan contract between banks and firms is assumed to be built from standard single period debt contracts as in Sharpe (1990). A single-period debt contract consists of a gross real interest rate on loans, R_t^L , and the corresponding repayment schedule,⁴²

$$(4) \quad \begin{cases} l_t R_t^L & \text{if investment is successful} \\ \nu & \text{if investment is unsuccessful} \end{cases}$$

where l_t is the size of the loan, equivalent to the indivisible project size chosen by a firm at time t , and ν refers to either the residual values of a investment or penalty levied on the unsuccessful young agents. For simplicity, it is assumed that no penalty is levied, i.e. $\nu = 0$.

⁴² This contract shows that if a firm succeeds in the investment, he repays loans with interest, but if not, a firm defaults and bank can have the ownership of residual value of the project. With the assumption of no residual value of project (and no penalty), $\nu = 0$, so banks cannot recover failed loans.

In the case of heterogeneous agents, we have a pooling equilibrium if there is no penalty, while a separating equilibrium if there is penalty levied on unsuccessful agents. That is, all young agents, regardless of their Types, want to borrow and start to their own business if there is no penalty. However, when we levy penalty to unsuccessful agents, in equilibrium, successful agents choose “borrowing”, while unsuccessful agent choose “no borrowing”. As mentioned, banks are unable to observe firm’s quality, *ex ante*. However, when banks engage in screening, they can distinguish high from low quality firms before they provide credit. Hence, banks plays pivotal role in allocating resources when there is no penalty as every agent try to borrow, regardless of his Type.

In the case of homogeneous agents, we have a pooling equilibrium regardless of whether $\nu = 0$ or not as the odds of success in investments follows a random process. In this case, banks’ screening activities are also important to allocate resource efficiently.

Table VII shows the comparison of the equilibrium and bank’s role between no penalty and penalty assumption. Previous literature shows that banks plays pivotal role in allocating resources efficiently. Taking consideration of chronic excess-demand for funds and banks’ positive role in allocating resources as well as concentrating the effect of banking market structure on the economy, hence, I need to confine to the case of no penalties.⁴³

⁴³ In the case of some penalties levied on unsuccessful agents, we have a separating equilibrium in this model. That is, Type 1 young agents borrow a credit to fund an investment, while Type 2 agents do not. In this case, screening activities of banks are not needed. Then, the screening activities are not important. In that case, the competitive banking system always leads to higher performance in terms of economic growth as the allocative efficiency of the monopoly banking system does not exist any longer. This,

Table VII
Comparison With / Without Penalty

		No Penalty ($\nu = 0$)	Penalty ($\nu \neq 0$)
Homogeneous Agent Case	Equilibrium	Pooling	Pooling
	Screening Activity	Important	Important
Heterogeneous Agent Case	Equilibrium	Pooling	Separating
	Screening Activity	Important	Unimportant

As in Bernanke and Gertler (1989), however, screening activities imply a cost, $b > 0$ ⁴⁴ where b is measured in goods. The screening cost is assumed to be proportional to the amount lent.⁴⁵ Note that banks lend all available funds; the screening cost is proportional to savings, i.e.

$$(5) \quad b = (1 - \mu)s_t$$

where μ is a measure of the level of development of the screening technology.⁴⁶

however, does not reflect the asymmetric information problem, existed between firms and banks, which banks are engaged in screening activities to allocate funds in a most profitable way.

⁴⁴ The presence of investment projects subjects to a costly state verification is essential in this model to understand both the relative advantage and relative disadvantage of a monopoly banking system compared to a competitive banking system. It is related to the co-evolution over time of an economy's real activity and its financial system. See Gurley and Shaw (1955)

⁴⁵ The advantage of this approach is that it makes screening cost depend upon size of banks. In other word, the contribution ratio for both banks, A and B to distinguish high and low quality firms are the same.

⁴⁶ Screening technology reflects the developments of financial intermediary. Numerous theoretical models suggest that financial intermediaries can lower the cost of researching potential investments, exerting

The screening technology reflects the developments of financial intermediary.⁴⁷ From the screening technology, banks produce valuable information about the quality of firms. Let q_t be the fraction of firms that are screened or verified. With a unit mass of firms, q_t is the aggregate measure of screened firms. Such information is used either only by screen-performing bank or by all banks, depending on the information externality.

3.6. Agents' Behavior and Factors Market

3.6.1. Homogeneous Agent

Every young agent has only one investment project and has preferences to make an investment on this project. As he has no endowment of capital or goods, he needs to borrow from a bank to finance the investment. Agents are assumed to care about their

corporate control, managing risk, mobilizing savings, and conducting exchanges. In addition, the level of financial intermediary development influences savings and allocation decisions in ways that may alter long-run growth rates. See, for example Levine, Loayza, and Beck (2000), Greenwood and Jovanovic (1990), Bencivenga and Smith (1991). As the screening cost is assumed to be dependent upon the level of screening technology, screening cost is lower when screening technology is high, and vice versa. Given the screening technology, a screening cost is proportional to a lending amount.

⁴⁷ Numerous theoretical models suggest that financial intermediaries can lower the cost of researching potential investments, exerting corporate control, managing risk, mobilizing savings, and conducting exchanges. In addition, the level of financial intermediary development influences savings and allocation decisions in ways that may alter long-run growth rates. See, for example Levine, Loayza, and Beck (2000), Greenwood and Jovanovic (1990), Bencivenga and Smith (1991). Levine, et al improve upon past measures of financial intermediary development, which consist of liquid liabilities of the financial system divided by GDP, the ratio of commercial bank assets divided by commercial bank plus central bank assets and the value of credits by financial intermediaries to the private sector divided by GDP.

lifetime consumption. That is, agents' utility is derived from consuming final goods both when young and when old. Let $c_{1,t}$ denote consumption of a young agent at time t , and let $c_{2,t+1}$ denote consumption of an old agent at time $t+1$. Young agents do not know whether their investment is successful or not. Hence, they want to maximize the expected utility as follows:

$$(6) \quad \max_{\{c_t, c_{t+1}\}} E_t[U(c_{1,t}, c_{2,t+1})] = \Phi \left((c_{1,t}^S)^\alpha + \beta (c_{2,t+1}^S)^\alpha \right) + (1 - \Phi) \left((c_{1,t}^U)^\alpha + \beta (c_{2,t+1}^U)^\alpha \right), \quad \alpha < 1$$

where superscript S refers to success in investment project, while superscript U refers to unsuccessful.

The successful young agents can produce a capital stock, equal to

$$(7) \quad K_t = l_t$$

reflecting the bank lending. Young agents produce the final good using capital and labor and pay back loans to banks. So they have the following disposable income:

$$(8) \quad DI_t^S = F(K_t, 1 + L_t) - w_t L_t - R_t^L K_t$$

where $F(K_t, 1 + L_t)$ is production using capital (K_t) and labor ($1 + L_t$). R_t^L is the gross interest rate on loans. Applying Euler's law, the disposable income reduced to real wages as marginal productivity of capital equals to interest rates on loan and marginal productivity of labor equals to real wage. That is,

$$(9) \quad R_t^L = \frac{\partial F(K_t, 1 + L_t)}{\partial K_t} = F_1(K_t, 1 + L_t) = \gamma k_t^{\gamma-1}$$

$$(10) \quad w_t = F_2(K_t, 1 + L_t) = (1 - \gamma) k_t^\gamma$$

$$(11) \quad DI_t^S = w_t$$

As mentioned, young agents save for future consumption in the form of deposits (d_t) and equity capital of banks (e_t), i.e. $s_t = d_t + e_t$. Let r_{t+1}^D be deposit interest rates and let r_{t+1}^E be rate of returns on equity capital. The no arbitrage condition⁴⁸ guarantees that revenue from deposits is exactly the same as revenue from equity capital, i.e. $r_{t+1}^D = r_{t+1}^E = r_{t+1}$. They make a decision of how much they consume in the current period and how much they consume in the next period. Hence, $c_{1,t}^S$ and $c_{2,t+1}^S$ are given as follows:

$$(12) \quad c_{1,t}^S = w_t - s_t^S, \quad c_{2,t+1}^S = s_t^S r_{t+1}$$

If the investment project is unsuccessful, young agents default and are hired by successful agents and receive wages. Let w_t be the competitive real wage. Similarly, $c_{1,t}^U$ and $c_{2,t+1}^U$ are given as follows.

$$(13) \quad c_{1,t}^U = w_t - s_t^U, \quad c_{2,t+1}^U = s_t^U r_{t+1}$$

As all agents have same preference and same income, savings from a successful young agent is the same as savings from a unsuccessful young agent. By plugging (12) and (13) into (6), we can derive optimal level of savings, s_t^* :

$$(14) \quad s_t^* = s_t^S = s_t^U = w_t \nu(r_{t+1})$$

⁴⁸ When interest on deposits is greater than rate of returns on equity capital, all agents prefer deposit until both rates of revenue equal each other and vice verse. We can derive same conclusion by differentiating utility function, expressed in equation (6) with respect to r_{t+1}^D and r_{t+1}^E . This has to happen for an interior solution.

where $v(r_{t+1})$ is $\left(1 + [\beta r_{t+1}^\alpha]^\frac{1}{\alpha-1}\right)^{-1}$ and superscript S and U denote successful and unsuccessful agents.

Therefore, a representative young agent wants to maximize the following CRRA utility function.

$$(15) \quad \max_{\{c_{1,t}, c_{2,t+1}\}} U(c_{1,t}, c_{2,t+1}) = c_{1,t}^\alpha + \beta c_{2,t+1}^\alpha, \quad \alpha < 1$$

$$\text{s.t. } c_{1,t} = w_t - s_t$$

$$c_{2,t+1} = s_t r_{t+1}$$

3.6.2. Heterogeneous Agent

Type 1 young agents want to maximize their own utility. As young agents have preference for operating their own business, Type 1 young agents make an investment to produce physical capital. To make this investment, they obtain credit by borrowing from banks. Their investments will turn out to be successful and they obtain physical capital.

$$(16) \quad K_t = l_t$$

Type 1 young agents produce the final good using physical capital and labor and then pay back loans to banks. They have the disposable income as follows:

$$(17) \quad DI_t^1 = F(K_t, 1 + L_t) - w_t^2 L_t - R_t^L K_t$$

where superscript 1 refers to Type 1 (high productivity) young agents and w_t^2 is wage for Type 2 agents. By applying Euler's Theorem, we can derive disposable income:

$$(18) \quad DI_t^1 = w_t^* + (w_t^* - w_t^2)L_t$$

where w_t^* is the real wage which is equivalent to marginal productivity of labor. It is assumed that $w_t^* \geq w_t^2$.⁴⁹ As discussed, $c_{1,t}^1$ and $c_{2,t+1}^1$ are given as follows.

$$(19) \quad c_{1,t}^1 = w_t^* + (w_t^* - w_t^2)L_t - s_t^1$$

$$c_{2,t+1}^1 = r_{t+1}s_t^1$$

Type 1 young agents' utility maximization problem, hence, is as follows.

$$(20) \quad \max \quad U(c_{1,t}^1, c_{2,t+1}^1) = (c_{1,t}^1)^\alpha + \beta(c_{2,t+1}^1)^\alpha$$

$$s.t \quad c_{1,t}^1 = w_t^* + (w_t^* - w_t^2)L_t - s_t^1$$

$$c_{2,t}^1 = r_{t+1}s_t^1$$

Type 2 young agents also want to maximize their own utility subject to a resource constraint. As young agents have preference for operating their own business, Type 2 young agents make an investment to produce physical capital in the case of no penalty for default. To make the investment, they also borrow credit from banks. Their investments turn out to be failures, thus they are doomed to default. They will supply their labor in successful lines of production and receive incentive real wages, w_t^2 , to induce the agent to choose output maximizing action.⁵⁰

⁴⁹ This assumption is reasonable in that wage is determined by marginal productivity of labor. We assumed that Type 2 agents have low productivity while Type 1 agents have high productivity. Hence, w_t^* is weighted average of both Type 1 and Type 2 agents' marginal productivity of labor.

⁵⁰ Under the full information about agent's productivity, we have two optimal incentive scheme. One is target output scheme and another is linear incentive payment. This problem is sort of full-information

Similarly, $c_{1,t}^2$ and $c_{2,t+1}^2$ are given as follows.

$$(21) \quad \begin{aligned} c_{1,t}^2 &= w_t^2 - s_t^2, \\ c_{2,t+1}^2 &= s_t^2 r_{t+1} \end{aligned}$$

where superscript 2 refers to Type 2 (low productivity) young agents.

Hence, Type 2 young agents' utility maximization problem is as follows.

$$(22) \quad \begin{aligned} \max \quad & U(c_{1,t}^2, c_{2,t+1}^2) = (c_{1,t}^2)^\alpha + \beta(c_{2,t+1}^2)^\alpha \\ \text{s.t.} \quad & c_{1,t}^2 = w_t^2 - s_t^2 \\ & c_{2,t+1}^2 = r_{t+1} s_t^2 \end{aligned}$$

In aggregate, the economy has following utility function:

$$(23) \quad \begin{aligned} \max \quad & \Phi U(c_{1,t}^1, c_{2,t+1}^1) + (1 - \Phi) U(c_{1,t}^2, c_{2,t+1}^2) \\ & = \Phi \left((c_{1,t}^1)^\alpha + \beta(c_{2,t+1}^1)^\alpha \right) + (1 - \Phi) \left((c_{1,t}^2)^\alpha + \beta(c_{2,t+1}^2)^\alpha \right) \\ \text{s.t.} \quad & c_{1,t}^1 = w_t^* + (w_t^* - w_t^2) L_t - s_t^1, \quad c_{2,t+1}^1 = r_{t+1} s_t^1 \\ & c_{1,t}^2 = w_t^2 - s_t^2, \quad c_{2,t+1}^2 = r_{t+1} s_t^2 \end{aligned}$$

Note that net profits derived from borrowing and investing a physical capital are zero as the loan interest rate equals marginal productivity of capital in production function. Unlike the homogeneous agent case, Both Type 1 and Type 2 agents have different wage level since they have different level of productivity.

principal-agent problem. In this case, the incentive compatibility constraint isn't "binding", hence, the Pareto efficient amount of output will always be produced. For details, see Varian (1992) pp.442-444.

3.7. Information Structure

We have two different approaches to model uncertainty. First, it is assumed that there are two types of investment projects: high quality and low quality, where quality indexes the probability of success in investment. Second, it is assumed that there are two types of agents; high productivity (H) and low productivity (L). The probability of success in investment for a high quality projects (or high productivity agents) (H) and low quality projects (or low productivity agents) (L) are p_H , p_L respectively, with $p_H > p_L$. For simplicity, it is assumed that $p_H = 1$ and $p_L = 0$. In other words, high quality projects (or high productivity agents) always succeed in the investment stage, while low quality projects (or low productivity agents) always fail in the investment stage.

In the homogeneous agent case, the quality of a project is not known by either banks or agents, ex ante. It is, however known the proportion of high type projects in the population. Let $\Phi \in [0,1]$ be time-invariant proportion of high quality projects in the population. It is assumed that the aggregate measure of high quality projects, Φ , is common knowledge. In addition, banks have access to a screening technology which allows them to distinguish high from low quality projects before they provide credit.

Unlike the homogeneous agent case, heterogeneous agent case assumes that young agents know their own types, while banks do not know the types of an individual young agent. They know, however, that aggregate measure of the proportion of Type 1 agent of the population is Φ . With probability of $\Phi p_H + (1 - \Phi)p_L$, hence, a firm can transform one unit of final goods into one unit of capital, and with probability of

$\Phi(1 - p_H) + (1 - \Phi)(1 - p_L)$, one unit of goods invested at the beginning of period t yields nothing at the end of period t . Note that $p_H = 1$ and $p_L = 0$. In other words, young Type 1 agents always succeed in the investment stage, while young Type 2 agents always fails in the investment stage.

Let $\eta(i) \in \{H, L\}$ be the perfect (screened) information of the firm i 's quality, where $\eta = H$ if the set-up stage is successful and $\eta = L$ if it fails and let $\tilde{\eta}(i) \in \{\tilde{H}, \tilde{L}\}$ be the noisy signal of $\eta(i) \in \{H, L\}$ as in Sharpe (1990)⁵¹. Let B^S and B^O be the screening banks and outside banks, respectively. The “screening banks”, B^S observe the firm i 's quality at the cost of b , while the “outside banks” that do not screen firm i , observe only a noisy signal of the outcome, $\tilde{\eta}(i) \in \{\tilde{H}, \tilde{L}\}$. The signal $\tilde{\eta}(i)$ is assumed to be fixed for any particular firm. That is, all “outside” banks observe the same outcome of that signal,⁵² and they do so without cost.

Suppose the conditional distribution function is given by

$$(24) \quad \begin{aligned} \text{prob}(\tilde{\eta} = \tilde{H} / H) &= \text{prob}(\tilde{\eta} = \tilde{L} / L) = (1 + \xi) / 2 \\ \text{prob}(\tilde{\eta} = \tilde{H} / L) &= \text{prob}(\tilde{\eta} = \tilde{L} / H) = (1 - \xi) / 2 \end{aligned}$$

⁵¹ The basic idea for noisy signal comes from Type I and II error in statistics. Type I error tells that bank rejects to provide credit to high quality firms, i.e. $\text{prob}(\tilde{\eta} = \tilde{L} / H)$, and Type II error implies that banks accept a loan application and give a credit to low quality firms, i.e. $\text{prob}(\tilde{\eta} = \tilde{H} / L)$.

⁵² I assume that a firm which rejected previously by one bank will not submit a loan application to other banks. Allowing a subsequent application leads to the “Winners Curse” in that the pool of loan applicants all banks faced is systematically worsening. If a lender has a customer relationship with a borrower, winners curse problem will be mitigated. See Shaffer (1998)

where $\xi \in [0,1]$ refers to degree of information externality.

If $\xi = 0$, then all probability is 0.5, which suggests that outside banks, B^O , do not have any clues that would allow them to distinguish high from low quality firms. In other words, Banks B^O learn nothing about a firm's quality. I call this the “no information externality” case. If $\xi = 1$, the probability that they correctly classify a firm's quality. In other words, outside banks know the firm's quality exactly as do the screening bank. This is called the “perfect information externality” case.

The assumption of the degree of information externality, except for perfect information externality implies asymmetric outcome observability, and in turn, it makes lenders have to expend some minimum level of resources to make sure they choose high quality projects. In the process of this monitoring, the lender learns more about the success of the firm's set-up stage than do outside banks. In the next section, I will show how the degree of information externality affects banks' optimal strategies for screening decision.

Bank will lose their willingness to engage in screening as the information externality grows. If there is a perfect information externality, the best strategy for a bank is to wait and see the outcomes of screening done by other banks. Coase (1960) and Hendricks and Porter (1996) show that when there is an information externality, the distinguishing characteristic of the strategy for market participants is delay and duplication. Hence, banks facing a high degree of information externality tend to invest less in the screening technology. As a consequence, however, the economy suffers an allocative inefficiency in that bank cannot recover loans to low quality firms.

3.8. Bank's Behavior and Payoffs

Consider an economy with N banks, where N is an exogenous number. Total saving is assumed to be S_t at time t , which is distributed equally among the N banks. Hence, a bank receives a savings of

$$(25) \quad s_{b,t}^j = S_t / N .$$

Consider a firm wishing to finance a project. The firm applies for credit. Suppose he receives credit according to loan contract, shown in Section 2.3 and starts an investment project. If the project is successful, it generates positive revenues for the bank that finances it, while if the project is unsuccessful, the resources lent are totally lost and revenues are zero.

Consider now the bank's choices. Note that the bank has a screening technology capable of distinguishing high quality projects from low quality projects. He can screen the firm before he provides credit at a screening cost, b . If a bank engages in screening, he makes a safe loan regardless of what other banks do and regardless of the information externality.

If the bank decides not to screen, two outcomes are possible. First, in the case of a perfect information externality and at least one of the other banks screens the firm, then the bank learns the firm's quality and makes a safe loan without sustaining the screening cost. Second, if there is no information externality or if no other bank screens the firm, the bank makes a risky loan whose expected payoff depends on the unconditional distribution of high quality projects, Φ . The following examples give useful insights to

understand the equilibrium payoffs of banks both with screening and with no screening activities.

3.8.1. All Banks Perform Screening

Suppose all banks are engaged in screening activities, i.e. $B^S = N$ and $B^O = 0$. Then only high quality firms will receive loans regardless of information externality as $p_H = 1$, $p_L = 0$. An individual bank can lend a maximum of $\mu s_{b,t}^j (= s_{b,t}^j - b)$, which is recovered completely. In the process of intermediation, high quality firms' idiosyncratic risk will be eliminated at the aggregate level. Hence, a bank's expected revenues will be

$$(26) \quad R_{t+1}^L \times \mu s_{b,t}^j$$

where R_{t+1}^L is interest rates on loan, which determined by loan contract and μ is the level of screening technology.

3.8.2. No Banks Perform Screening

Suppose no banks engage in screening activities, i.e. $B^S = 0$ and $B^O = N$. Then, a bank has to lend to all entrepreneurs indiscriminately, regardless of the information

externality.⁵³ In this case, the lending assets ($s_{b,t}$) lent to high quality firms (Φ) turns out to be successful (physical) capital, so a bank's expected return will be

$$(27) \quad R_{t+1}^L \times \Phi s_{b,t}^j$$

where Φ is the time-invariant proportion of high quality firms.

3.8.3. Some Banks Perform Screening

Suppose the proportion of $q_t \in (0,1)$ to total banks is engaged in screening activities, i.e $B^S = q_t N$ and $B^O = (1 - q_t) N$. Suppose there is perfect information externality. In other words, screening results are transmitted to other banks immediately. Then, outside banks offers better contracts to screened high quality firms. If $q_t \in (0, 0.5)$, outside banks offer better contracts to screened high quality firms, and screening banks cannot lend to their own screened high quality firms and instead give credits to all unscreened firms. Outside banks, who have a competitive advantage on the loan interest rates, lend to screened high quality firm. Excess credit will be given to all firms unscreened. If $q_t \in (0.5, 1)$, outside banks lend all their available credit to screened high quality firms. Screening banks lend to screened high quality firms first, and then lend to all unscreened firms indiscriminately

⁵³ Information externality problem exists when any bank creates information by screening firms. Hence, if no bank screens, there is no possibility to have information externality problem.

Suppose there is no information externality. Screening banks can lend to their own screened high quality firms, while outside banks lend to all unscreened firms indiscriminately.

In both cases, of the lending assets $(1 - (1 - \mu)q_t)s_t$, those lent to high quality firms $((\Phi + (\mu - \Phi)q_t)s_t)$ turn out to be successful (physical) capital. Therefore, in aggregate, banks' expected return will be

$$(28) \quad R_{t+1}^L \times (\Phi + (\mu - \Phi)q_t)s_t$$

where $(\mu - \Phi)$ is the increase in allocative advantage from screening activities.

Note also that to be economically meaningful for the screening activities, the benefit from screening is greater than the screening cost. In other words, the screening cost, $b = (1 - \mu)s_{b,t}^j$, is less than the investment loss from giving credit to low quality firms (benefits from screening), i.e. $(1 - \Phi)s_{b,t}^j$.⁵⁴ From this condition, we can derive a relation as follows:

$$(29) \quad \mu > \Phi$$

Appendix B shows how the results change when this assumption is relaxed.

⁵⁴ As the developments of the financial infrastructure such as credit rating agency, networking, advanced information technology, banks can easily discriminate high quality firms from low quality firms. In that sense, the assumption that screening cost is less than the investment loss from lending to low quality firms is reasonable from the practical point of view.

3.9. Credit and Capital

This section compares the aggregate credit and physical capital between screening equilibrium and no screening equilibrium. From this comparison, we get an idea of the main advantages and/or disadvantages of a competitive versus monopolistic banking system.

Definition 1: Let X_t^N be aggregate credits provided to all firms under no screening, and X_t^S be aggregate credits to all firms under full screening, respectively. In addition, let X_t^R be aggregate credits provided to all firms when banks screen firms with probability $q_t \in (0,1)$.

Definition 2: Let x_t^N be credits provided to an individual firm under no screening, and x_t^S be credits to an individual firm under full screening, respectively. In addition, let x_t^R be credits provided to an individual firm when banks engage in screening firms with probability q_t ,

Proposition 1: For the aggregate credit to all firms by banks, $X_t^N > X_t^R > X_t^S$ holds.

However, for the credit to an individual firm, $x_t^N < x_t^R < x_t^S$ holds.

Proof . See Appendix C.1.

Proposition 1 shows intuitively how the no-screening and full-screening equilibriums have different implications for credit and successful physical capital. Table VIII compares the total credit, the credit per firms and the successful capital among full screening, no screening and randomizing. In the no-screening equilibrium, we have the

largest credit but suffer an allocative inefficiency. In other words, as seen in Section 2.5, if banks lend to all firms indiscriminately, only credit to high quality firms will become physical capital and lending to low quality firms is not recovered. Contrary to the no-screening case, in the full screening equilibrium, we have the least credit in aggregate but benefits from allocative efficiency. In other words, total credit to firms would be reduced because of the costs of screening, however, the credits supplied to firms are completely recoverable as only high quality firms are recipients of loans. In the randomizing equilibrium, the aggregate credit supplied and the amount of physical capital is in between the no-screening equilibrium and the screening equilibrium.

Table VIII
Comparison of Credit and Capital

	Full Screening	Randomizing	No Screening
Total Credit	μS_t	$[1 - q_t(1 - \mu)]S_t$	S_t
Credit per firms	$(\mu/\Phi)s_t$	$((1 - q_t(1 - \mu))/(1 - q_t(1 - \Phi)))s_t$	s_t
Successful Capital	μS_t	$[\mu q_t + (1 - q_t)\Phi]S_t$	ΦS_t

4. EQUILIBRIUM IN THE BANKING SYSTEM

Note that there are N banks in the economy, where N is an exogenous number.

Define $S_t = \int_0^1 s_t^i di$ be equilibrium level of aggregate saving of young agents, where s_t^i is

the savings of young agent i . Note that $S_t = s_t$ with a unit mass as every young agent chooses same amount of savings. The total saving, S_t is distributed equally among banks. Hence, a bank receives a saving of $s_{b,t}^j = S_t/N$. Using these savings, a bank offers loan contract to firms.

To incorporate the nature of uncertainty into the model, I follow the homogeneous agent case. Hence, agents are ex ante identical and they do not know the outcome of their investment.

Consider a bank's choices. Note that a bank can access the screening technology and screen firms before providing credit if he pays the screening cost. If a bank engages in screening, he makes a safe loan regardless of what other banks do and regardless of the information externality. However, if the bank does not screen, two outcomes are possible. First, in the case of a high (or perfect) information externality, the bank learns a firm's quality and makes a safe loan without sustaining the screening cost if one of the other banks screens the firm. Second, if there is a low (or no) information externality, or if no other banks screen the firm, the bank makes a risky loan whose expected payoff depends on the unconditional distribution of high quality projects, Φ .

Now, the optimal strategies of banks in competitive banking system, duopoly banking system and monopoly banking system will be analyzed. The optimal strategies of both competitive banks and duopoly banks are dependent upon the degree of the information externality. For example, the optimal strategies for both a competitive bank and duopoly banks are screening if there is a low information externality, but not screening if there is a high information externality.⁵⁵ The optimal strategy of a monopoly bank, however, is independent of the information externality. A monopoly bank always chooses screening as its optimal strategy.

The payoffs for a bank are its profits. Profits equal the revenue minus cost of funding and screening. The revenue of a bank is determined by the interest rates on lending, R_{t+1}^L , multiplied by the successful physical capital. The cost of funds for a bank is determined by the interest rates on deposit (or the return on equity capital), r_{t+1} , multiplied by saving. The cost of screening is proportional to savings, as mentioned.

As banks are institutions owned by old agents, the profits of banks, if any, would belong to old agents. It is assumed that there is no restriction on entry or exit in the banking industry. Competition with free entry and exit in the competitive banking system, however, assures that a competitive bank makes zero profit.

⁵⁵ If there is high information externality, the best strategy for a bank is to wait and see the outcomes of screening which other banks are engaged in. Coase (1960) and Hendricks and Porter (1996) support this view, showing that when there is an information externality, the distinguishing characteristic of the mixed strategy for market participants is delay and duplication. Hence, banks facing high degree of information externality tend to invest less on screening technology. As a consequence of it, however, the economy suffers an allocative inefficiency in that banks give credit to low quality firms.

4.1. Competitive Banking Industry

In this scenario, we assume that the number of banks, N , is sufficiently large. The competitive banks are assumed to be simultaneous-move, Nash-competitors⁵⁶. In other words, all banks choose strategies at the same time which give them maximum payoffs, taking other banks' strategies given.

A bank $j \in N$ chooses a strategy z_j^m where the superscript m refers to a set of strategies, and subscript j denotes bank j . A set of strategies, m , consists of no-screening (NS) and screening (S). Let $NS=1$ and $S=2$. Then a set of strategies consists of $\{1, 2\}$, i.e. $m = \{NS = 1, S = 2\}$. For example, z_1^1 denotes the strategy of bank 1, which is not screening, and z_2^2 denotes the strategy of bank 2, which is screening. A bank chooses its optimal strategies, either no screening ($m=1$) or screening ($m=2$) simultaneously, considering other banks' strategies and corresponding payoffs.

The payoffs are expressed in terms of profits, π_i . In the Nash equilibrium, each bank has symmetric payoffs. That is, the payoffs of a bank under a strategy bundle (z_1^1, z_2^2) equals that of any other bank under the strategy bundle (z_1^2, z_2^1) . The optimal strategies and payoffs vary, depending upon the degree of information externality, ξ .

Definition 3: Let a competitive bank's profit be denoted by $\pi_c^S(\xi)$ under screening equilibrium, and by $\pi_c^{NS}(\xi)$ under no screening equilibrium, respectively.

⁵⁶ Hence, competitive banks know strategies of their rival banks and each bank's strategy is an optimal response to the other banks' strategies.

Proposition 2: There exists a critical degree of information externality, ξ^* such that $\pi_C^S(\xi^*) = \pi_C^{NS}(\xi^*)$ for competitive banks, and $\pi_C^S(\xi) > \pi_C^{NS}(\xi)$ for $\xi < \xi^*$ and $\pi_C^S(\xi) < \pi_C^{NS}(\xi)$ for $\xi > \xi^*$.

Proof. See Appendix C.2.

Proposition 2 implies that in a competitive banking system, banks will retreat from engaging in screening activities as the degree of information increases. In Nash equilibrium, all competitive banks will be in the no screening equilibrium if the degree of the information externality is greater than the critical level, while all banks will be in the screening equilibrium if it is less than the critical level.

As shown in Appendix C.2, the critical level of information externality is

$$(30) \quad \xi^* = 2\mu - 1$$

By reviewing the relationship between the critical level of the information externality and the screening technology, we can show a highly efficient screening technology, i.e. $\mu \rightarrow 1$, causes the critical degree of the information externality to converge to one, i.e. $\xi^* = 1$. This implies that the screening equilibrium has higher payoffs than the no screening equilibrium as financial markets advance.

As described in the introduction, we might interpret the evidence as suggesting that the degree of information externality has recently increased in the banking industry. Hence, competitive banks will retreat from screening and have a tendency to convergence to the no screening equilibrium. In the next section, I will analyze both the no screening equilibrium and the screening equilibrium.

4.1.1 No Screening Equilibrium

I will show that no competitive banks will engage in screening if the degree of the information externality is greater than the critical level.

Suppose a competitive bank is engaged in screening and hence discriminates in favor of high quality firms at the cost of paying the screening cost, b . As soon as the high quality firms are revealed, the outside banks observe the result immediately if the information externality is high. Then the outside banks offer a lower lending rate to the screened high quality firms. Of course, as the screened, high quality firms want to borrow at the lowest cost, they make a contract with a bank that offers the lowest lending rates. Hence, screening banks cannot recover the screening cost.

In this situation, the optimal strategies of competitive banks are to wait and see the outcome of other banks' screening activities.⁵⁷ In Nash equilibrium, hence, a competitive bank has no incentive to engage in screening activities, and wants to diversify risk by lending to as many firms as they can. In other words, a competitive bank faces the free riding problem and this, in turn, leads to a no screening equilibrium.

⁵⁷ Coase (1960), Hendricks and Porter (1996) support this view, showing that when there is an information externality, the distinguishing characteristic of the mixed strategy for market participants is delay and duplication. Hence, banks facing high degree of information externality tend to invest less on screening technology. As a consequence of it, however, the economy suffers an allocative inefficiency in that banks give credit to low quality firms.

Definition 4: A strategy profile $z^* = (z_1^{m*}, z_2^{m*}, \dots, z_N^{m*})$ constitutes a Nash equilibrium for banks in the competitive banking industry if for every $j=1, \dots, N$, $\pi_j = 0$ and $\pi(z_j^{m*}, z_{-j}^{m*}) \geq \pi(z_j^{m'}, z_{-j}^{m*})$ for all $z_j^{m'} \in Z_j$.

Proposition 3: The unique Nash equilibrium of the competitive banking industry is $z^* = (z_1^1, z_2^1, z_3^1, \dots, z_N^1)$ if $\xi > \xi^*$, i.e. no banks are engaged in screening activities.

Proof. See Appendix C.3.

Proposition 3 shows that competitive banks have no incentive to be engaged in screening activities in the case of substantially higher degree of information externality. Instead, they want to diversify risk by lending to all firms indiscriminately. In other words, competitive banks face the free riding problem in the case of a high information externality that in turn, leads to the no screening equilibrium.

When a competitive bank lends to all firms indiscriminately, of the lent assets (s_t), only that lent to high quality firms (Φ) turns out to be successful (physical) capital, i.e.

$$(31) \quad K_{t+1} = \Phi S_t$$

With unit mass for each generation, $S_t = s_t$. From equation (2), the equilibrium capital stock is

$$(32) \quad k_{t+1} = \Phi^2 s_t$$

A bank's expected return will be $R_{t+1}^L \times \Phi s_{b,t}^j$ where Φ is the time-invariant proportion of high quality firms. In aggregate, the total return of banks will be $R_{t+1}^L \times \Phi s_t$ with unit mass. From the zero profit condition,

$$(33) \quad R_{t+1}^L \Phi S_t = r_{t+1} S_t$$

where r_{t+1} is the cost of funds (I call it deposit interest rate afterward) and R_{t+1}^L is the interest rate on loans. The rental rate for successful physical capital, R_t^L , and real wage w_t are determined in equation (9) and (10). Plugging the optimal amount of saving at time t , s_t^* , expressed in in equation (14) into CRRA utility function, expressed in equation (15), we can derive deposit interest rates as follows,

$$(34) \quad r_{t+1}^C = \left(\frac{1}{\beta}\right)^{\frac{1}{\alpha}} \left[\frac{w_t - s_t^*}{s_t^*} \right]^{\frac{\alpha-1}{\alpha}}$$

where superscript C refers to a competitive banking system.

Note that $S_t = \int_0^1 s_t^i di$ is equilibrium level of aggregate saving of young agents and

that $S_t = s_t^*$ with a unit mass as all agents choose same s^* . Only lending to high quality firms will become physical capital at next period when banks do not screen the firms, as mentioned. From equation (32),

$$(35) \quad s_t = \Phi^{-2} k_{t+1}$$

Substituting (16), (35) into (34), we have

$$(36) \quad r_{t+1}^C = \left(\frac{1}{\beta}\right)^{\frac{1}{\alpha}} \left[\frac{(1-\gamma)k_t^\gamma - \Phi^{-2}k_{t+1}}{\Phi^{-2}k_{t+1}} \right]^{\frac{\alpha-1}{\alpha}}$$

Substituting equations (14), (36) into (33), I obtain

$$(37) \quad \Phi \gamma k_{t+1}^{\gamma-1} = \left(\frac{1}{\beta}\right)^{\frac{1}{\alpha}} \left(\frac{[\Phi^2(1-\gamma)k_t^\gamma k_{t+1}^{-1} - 1]}{[\Phi^2(1-\gamma)k_t^\gamma k_{t+1}^{-1} - 1]^{\frac{1}{\alpha}}} \right)$$

This shows the equilibrium law of motion for the per capita capital stock, k in the competitive credit market⁵⁸ in the case of $\xi > \xi^*$.

4.1.2 Screening Equilibrium

In Nash equilibrium, all competitive banks⁵⁹ participate in screening activities if $\xi < \xi^*$ as the screening cost is less than the investment loss from lending to low quality projects. As the payoffs of competitive banks are higher when they are engaged in screening activities, the best strategy is to screen all firms. The point is that they do not suffer free riding problem if the level of the information externality in the banking industry is less than the critical level. For the purpose of comparison between no-screening equilibrium and screening equilibrium, hereafter, I will call screening equilibrium as equilibrium in the monopolistically competitive markets.

Proposition 4: The unique Nash equilibrium of the competitive banking industry is

$$z^* = (z_1^2, z_2^2, z_3^2, \dots, z_N^2) \text{ if } \xi < \xi^*.$$

Proof. See Appendix C.4.

⁵⁸ The right hand side refers marginal cost, while the left hand side refers marginal revenue per a capital stock in the competitive banking system.

⁵⁹ In the economy with incomplete, asymmetric information, banks do not satisfy the assumption of competitive market. Instead, it satisfies the assumption of monopolistically competitive market. For example, it has the property of monopoly market in that a bank has a monopoly power for the firms that he contacts. While it has the property of competitive market in that the number of bank is sufficiently large to assure no excess margin and it is free to enter and/or exit in the market.

As banks screen all firms, they can lend only to high quality firms. As in Proposition 1, in screening equilibrium, total credit available is total saving minus screening cost, i.e. $X_{t+1}^S = \mu S_t$. With a unit mass in each generation, $\mu S_t = \mu s_t$. As all credits are allocated to only high quality firms, all of those credits will be turned into productive capital, i.e.

$$(38) \quad K_{t+1} = \mu s_t$$

The equilibrium capital-labor ratio is given by

$$(39) \quad k_{t+1} = \Phi \mu s_t$$

From equation (39),

$$(40) \quad s_t = (\Phi \mu)^{-1} k_{t+1}$$

Similarly, we can derive the equilibrium level of saving at time t , s_t^* from the utility maximization problem, expressed in equation (7). From the market clearing condition, we can also derive deposit interest rates, r_{t+1} .

$$(41) \quad r_{t+1}^{MC} = \left(\frac{1}{\beta}\right)^{\frac{1}{\alpha}} \left[\frac{(1-\gamma)k_t^{\gamma} - (\Phi \mu)^{-1} k_{t+1}}{(\Phi \mu)^{-1} k_{t+1}} \right]^{\frac{\alpha-1}{\alpha}}$$

where the superscript MC refers to monopolistic competition. From banks' zero profit condition,

$$(42) \quad \mu R_{t+1} s_t = r_{t+1}^{MC} s_t$$

Substituting equation (14), (41) into (42) and canceling out the common factor s_t ,

$$(43) \quad \mu \gamma k_{t+1}^{\gamma-1} = \left(\frac{1}{\beta}\right)^{\frac{1}{\alpha}} \left(\frac{[\mu \Phi (1-\gamma) k_t^{\gamma} k_{t+1}^{-1} - 1]}{[\mu \Phi (1-\gamma) k_t^{\gamma} k_{t+1}^{-1} - 1]^{\frac{1}{\alpha}}} \right)$$

This shows the equilibrium law of motion for the per capita capital stock, k in the competitive banking system in the case of $\xi < \xi^*$.

4.2. Duopoly Banking Industry

In this economy, it is assumed that there are $N > 1$ banks. Suppose $N=2$ (Duopoly)⁶⁰. Both banks are Bertrand competitors.⁶¹ Consider a two stage game. In stage one, the banks decide whether to screen or not. In stage two, they choose the price at the market clearing loan amount. Recall that they lend all available credit.

Let R_i^L be the loan interest rates charged by bank i . By symmetry, bank i 's reaction function is $\Upsilon_i(R_j^L) = R_i^{L*}$ and bank j 's reaction function is $\Upsilon_j(R_i^L) = R_j^{L*}$. The Nash (Bertrand) equilibrium satisfies $R_i^{L*} = \Upsilon_i(R_j^{L*})$, and $R_j^{L*} = \Upsilon_j(R_i^{L*})$. Note that savings are distributed evenly between banks. This implies that both banks offer the same deposit interest rate. Hence, each bank gathers half of total savings.⁶²

⁶⁰ The duopoly ($N=2$) model can be extended to the oligopoly ($N>2$) model. The results of the duopoly model are the same in quality as that of the oligopoly model. See Cetorelli and Peretto (2000)

⁶¹ In Bertrand competition, each bank chooses its price (i.e., interest rates on deposits and loans) both simultaneously and non-cooperatively. A Nash equilibrium in prices-sometimes referred to as a Bertrand equilibrium- is a pair of prices such that each bank's price maximize that bank's profit given other bank's price.

⁶² In this economy, banks are identical both in cost and revenue function. And they have same screening technology. Therefore, there is no incentive for saver to prefer one bank to another bank.

4.2.1 No Screening Equilibrium

No duopoly banks will be engaged in screening if the degree of information externality is greater than the critical level of information externality in the banking industry, as mentioned. Note also that high information externality implies that both banks may suffer a free riding problem. Therefore, the bank i 's gross profit depends on what other bank do. The profit profile for bank i is:

$$(44) \quad \Pi_1 : \pi_i^{S,S} = R_{t+1}^L(x_i - b) - r_{t+1}x_i = R_{t+1}^L\left(\frac{\mu S_t}{2}\right) - r_{t+1}\frac{S_t}{2} \text{ if (both) screen}$$

$$\Pi_2 : \pi_i^{N,S} = R_{t+1}^Lx_i - r_{t+1}x_i = R_{t+1}^L\frac{S_t}{2} - r_{t+1}\frac{S_t}{2} \text{ if not screen but other bank screens}$$

$$\Pi_3 : \pi_i^{S,N} = R_{t+1}^L\Phi(x_i - b) - r_{t+1}x_i = R_{t+1}^L\left(\frac{\Phi\mu S_t}{2}\right) - r_{t+1}\frac{S_t}{2} \text{ if screen but others not}$$

$$\Pi_4 : \pi_i^{N,N} = R_{t+1}^L\Phi x_i - r_{t+1}x_i = R_{t+1}^L\frac{\Phi S_t}{2} - r_{t+1}\frac{S_t}{2} \text{ if both do not screen}$$

Proposition 5: The following relationship holds: $\Pi_2 > \Pi_1 > \Pi_4 > \Pi_3$.

Proof: See Appendix C.5.

Suppose a duopoly bank is engaged in screening and hence discriminates in favor of high quality firms at the expense of paying the screening cost, b . As soon as the high quality firms are revealed, an outside bank observes the result immediately as the information externality is high. Then, an outside bank offers a lower lending rate to the screened, high quality firms. Of course, as the screened, high quality firms want to borrow at the lowest cost, they contract with the outside bank, which offers lower

lending rates. Hence, the screening bank cannot recover screening cost and will have a loss.

In this situation, the optimal strategy of a duopoly bank is to wait and see the outcomes of the other bank's screening activities, just as it was in a similar situation with competitive banks. In Nash equilibrium, hence, a duopoly bank has no incentive to be engaged in screening activities, and wants to diversify risk by lending to as many firms as possible. In other words, a duopoly bank faces the free riding problem and it, in turn, leads to no screening equilibrium.

Definition 5: A strategy profile $z^* = (z_1^{m*}, z_2^{m*})$ constitutes a Nash equilibrium for duopoly banks if for every $j=1,2$, $\pi_j = 0$ ⁶³ and $\pi(z_j^{m*}, z_{-j}^{m*}) \geq \pi(z_j^{m'}, z_{-j}^{m*})$ for all $z_j^{m'} \in Z_j$.

Proposition 6: The unique Nash equilibrium of the duopoly banking industry is $z^* = (z_1^1, z_2^1)$ if $\xi > \xi^*$, i.e. no banks are engaged in screening activities.

Proof: See Appendix C.6

The Nash equilibrium in the duopoly banking system is identical to that in the competitive banking system. This result can be extended to the oligopoly ($N > 2$) model.

⁶³ In Bertrand competition, each bank charges the competitive price, i.e. $R_{i,t+1}^L = R_{j,t+1}^L = \frac{r_i}{\Phi}$. Hence, in equilibrium, banks do not make profits

4.2.2 Screening Equilibrium

In Nash equilibrium, all duopoly banks participate in screening activities if $\xi < \xi^*$ as the screening cost is less than the investment loss from not screening. As the payoffs of duopoly banks are higher when they engage in screening activities, the best strategy for duopoly banks is to screen all firms in the case of a low information externality. The point is that the banks do not suffer free riding problem if information externality in the banking industry is less than the critical level of the information externality.

Proposition 7: The unique Nash equilibrium of the duopoly banking industry is $z^* = (z_1^2, z_2^2)$ if $\xi < \xi^*$.

Proof. See Appendix C.7.

As with the no screening equilibrium, the Nash equilibrium in the duopoly banking system is identical to that in the competitive banking system. In addition, this result will be extended to the oligopoly model, too. Hence, the duopoly model converges to competitive model. In this context, setting $N > 1$ allows us to consider a competitive banking system.⁶⁴

⁶⁴ Note that although the Nash equilibrium of duopoly banks is no screening, they know that full screening equilibrium is better. Hence, if they commit to coordination for getting screening equilibrium, in aggregate, their payoffs converge to full screening equilibrium. For example, if one bank deviates and is not engaged in screening activity, the payoffs of whole banking industry is $\Pi_2 + \Pi_3$, which is less than $2\Pi_1$. This result can also be extended to $N > 2$ banks oligopoly model. For the details, see Cetorelli and Peretto (2000)

4.3. Monopoly Banking Industry

In this economy, there is only one bank, a monopoly bank, who tries to maximize its profit. Unlike the competitive bank, a monopoly bank can make positive profits. Since a monopoly bank does not face any free-riding threat and by assumption of $\mu > \Phi$, he will screen all firms. As a result of screening, he lends only to high quality firms. Hence, total volume of credit issued by a monopoly bank at time $t+1$ is total savings minus screening cost as seen in Proposition 1. Hence, $X_{t+1}^S = \mu S_t$. This credit will be turned into productive capital, as mentioned, i.e. $K_{t+1} = \mu S_t$. With a unit mass of population, $S_t = s_t$. Hence, the equilibrium capital-labor ratio is same as in the monopolistically competitive banking system, given by $s_t = (\Phi\mu)^{-1} k_{t+1}$.

The profit maximization problem of a monopoly bank is:

$$(45) \quad \underset{\{S_t\}}{\text{Max}} \quad \mu R_{t+1}^L s_t - r_{t+1} s_t$$

where R_{t+1}^L and r_{t+1} are well defined demand and supply schedules of capital. This problem is identical to the problem of competitive market under $\xi < \xi^*$. The main difference is how the deposit rate is determined. A monopoly bank chooses the interest rate on deposits in order to maximize her profit, while in a competitive banking system, this rate is determined by the banks' zero profits condition. Recall that under a monopoly banking system, total credit supplied to firms is less than total savings from old

generation, due to screening cost. However, it has a higher expected return per credit. Of course, a monopoly bank has to pay back depositors for savings, s_t .

The equilibrium in the credit market is determined by the solution of the bank's profits maximizing problem, expressed in equation (45). After substituting and rearranging, the bank's problem is given by

$$(46) \quad \text{Max}_{\{k_{t+1}\}} = \Phi^{-1} \gamma k_{t+1}^{\gamma} - \left(\frac{1}{\beta}\right)^{\frac{1}{\alpha}} [\Phi \mu (1 - \gamma) k_t^{\gamma} k_{t+1}^{-1} - 1]^{\frac{\alpha-1}{\alpha}} (\Phi \mu)^{-1} k_{t+1}$$

The first order condition in the monopoly credit market at any time t , and the dynamic equilibria satisfy

$$(47) \quad \gamma^2 k_{t+1}^{\gamma-1} = \left(\frac{1}{\beta}\right)^{\frac{1}{\alpha}} \left(\frac{\left[\frac{\Phi(1-\gamma)}{\alpha} k_{t+1}^{-1} k_t^{\gamma} - \mu^{-1} \right]}{\left[\Phi \mu (1 - \gamma) k_{t+1}^{-1} k_t^{\gamma} - 1 \right]^{\frac{1}{\alpha}}} \right)$$

This shows the equilibrium law of motion for the per capita capital stock, k , under a monopolistic banking system. (See Appendix C.8)

Table IX compares the equilibrium law of motion in each banking system. In competitive and duopoly banking system, banks engage in screening when the degree of information externality is low, while they do not engage in screening when the degree of information externality is high. However, a monopoly bank engages in screening regardless of the degree of information externality. As mentioned, the right hand side of each equation implies the marginal cost of each banking system and the left hand side implies the marginal revenue of each banking system.

Table IX
Comparison of Equilibrium Law of Motion

Market Structure	Optimal Strategy	Equilibrium Law of Motion
Competitive & Duopoly	Screening (Low ξ)	$\mu\gamma k_{t+1}^{\gamma-1} = \left(\frac{1}{\beta}\right)^{\frac{1}{\alpha}} \left(\frac{[\mu\Phi(1-\gamma)k_t^{\gamma}k_{t+1}^{-1} - 1]}{[\mu\Phi(1-\gamma)k_t^{\gamma}k_{t+1}^{-1} - 1]^{\frac{1}{\alpha}}} \right)$
	No Screening (High ξ)	$\Phi\gamma k_{t+1}^{\gamma-1} = \left(\frac{1}{\beta}\right)^{\frac{1}{\alpha}} \left(\frac{[\Phi^2(1-\gamma)k_t^{\gamma}k_{t+1}^{-1} - 1]}{[\Phi^2(1-\gamma)k_t^{\gamma}k_{t+1}^{-1} - 1]^{\frac{1}{\alpha}}} \right)$
Monopoly	Screening (rain or shine)	$\gamma^2 k_{t+1}^{\gamma-1} = \left(\frac{1}{\beta}\right)^{\frac{1}{\alpha}} \left(\frac{\left[\frac{\Phi(1-\gamma)}{\alpha} k_t^{\gamma}k_{t+1}^{-1} - \mu^{-1} \right]}{[\mu\Phi(1-\gamma)k_t^{\gamma}k_{t+1}^{-1} - 1]^{\frac{1}{\alpha}}} \right)$

5. COMPARISON OF STEADY STATE LEVEL OF CAPITAL

Now, I compare the long-run equilibria of two distinctive economies: monopoly and competitive market. The long-run capital stock in a duopoly banking system is the same as the one that obtained from a competitive banking system, as I derived in previous section. Specifically, I compare the long-run equilibrium of capital obtained in a competitive banking system versus a monopoly banking system. In addition, I compare it under both a high information externality and a low information externality. A competitive bank has a no screening equilibrium in the case of a high information externality, while it has a screening equilibrium in the case of low information externality, as analyzed. Henceforth, the no-screening equilibrium is called the equilibrium in a competitive banking system, while screening equilibrium is called the equilibrium in a monopolistically competitive banking system. Next section analyzes how the degree of information externality affects bank's behavior and its long run equilibrium of capital.

5.1. Steady State Level of Capital Stock

Definition 6: Let k_C , k_{MC} and k_M be the steady state level of capital for an economy with a competitive, a monopolistically competitive and a monopoly banking system, respectively, such that

$$(48) \quad \Phi \gamma k_C^{\gamma-1} = \left(\frac{1}{\beta} \right)^{\frac{1}{\alpha}} \left(\frac{[\Phi^2(1-\gamma)k_C^{\gamma-1} - 1]}{[\Phi^2(1-\gamma)k_C^{\gamma-1} - 1]^{\frac{1}{\alpha}}} \right) \quad (\xi > \xi^*)$$

$$(49) \quad \mu \gamma k_{MC}^{\gamma-1} = \left(\frac{1}{\beta} \right)^{\frac{1}{\alpha}} \left(\frac{\Phi \mu (1-\gamma) k_{MC}^{\gamma-1} - 1}{[\Phi \mu (1-\gamma) k_{MC}^{\gamma-1} - 1]^{\frac{1}{\alpha}}} \right) \quad (\xi < \xi^*)$$

$$(50) \quad \gamma^2 k_M^{\gamma-1} = \left(\frac{1}{\beta} \right)^{\frac{1}{\alpha}} \left(\frac{\left[\frac{\Phi(1-\gamma)}{\alpha} k_M^{\gamma-1} - \mu^{-1} \right]}{[\Phi \mu (1-\gamma) k_M^{\gamma-1} - 1]^{\frac{1}{\alpha}}} \right) \quad (\forall \xi)$$

The left-hand side of each equation denotes the marginal revenue (MR) of lending assets for a bank, while the right-hand side refers to the marginal cost (MC) of lending assets for a bank. Each equation shows that in equilibrium, marginal revenue will be equal to the marginal cost.

Proposition 8: There is unique steady state equilibrium under each of the banking market structures considered.

Proof. See Appendix C.9

In next section, I will compare the steady state level of capital stock in a competitive banking system with that in a monopoly banking system under different degrees of information externality.

5.2. Comparison of Steady State Level of Capital Stock

Let us compare screening equilibrium with no screening equilibrium in a competitive banking system. This analysis gives us insight how long run equilibrium changes as information externality increases.

Proposition 9: Under a competitive banking system, the screening equilibrium yields a higher steady state level of capital than a no-screening equilibrium, i.e. $k_C < k_{MC}$.

Proof. See Appendix C.10

Proposition 9 implies that the steady state level of capital decreases as information externality increases under a competitive banking system. It supports the conventional wisdom which suggests that the market equilibrium is generally inefficient in the presence of externalities.⁶⁵ As mentioned, information obtained by a bank has been transmitted more rapidly than ever among banks. This, in turn, is leading to a substantial information externality.

5.2.1. Low Information Externality

Proposition 10: In the case of low information externality ($\xi < \xi^*$), a monopolistically competitive banking system leads to a higher steady state level of capital than a

⁶⁵ When there is an information externality, the distinguishing characteristic of the mixed strategy is delay and duplication. And if banks fail to internalize the value of externality, banks invest less, which implies no screening in this paper. Mergers and acquisitions are suggested as one of the solutions for the externalities problem. For the details, see Coase (1960) and Hendricks and Porter (1996).

monopoly banking system if the degree of financial markets developments is higher than the degree of capital intensity, i.e. $k_{MC} > k_M$ if $\mu > \gamma$.

Proof. See Appendix C.11.

Intuitively, if both competitive banks and a monopoly bank are participating in screening activities, then the advantage of allocative efficiency in the monopoly banking system will be washed away. In this case, the loss in output associated with the typical rent extraction activities of a monopoly bank generally leads to inefficiency in the economy. Therefore, in the low information externality case and with a well-developed financial market system, the long run equilibrium of per capita capital stock is higher in the competitive banking system.

Let us think about the condition of $\mu > \gamma$ more carefully. What I label as the degree of financial market development, μ , represents the level of screening cost in the financial industry, while the degree of capital intensity, γ , is an indicator of the elasticity of capital demand. For countries with a bank-based financial system⁶⁶, banks have a pivotal role in terms of getting society's saving to firms, exerting corporate control, and providing risk management tools. Under this financial system, as firms depend heavily

⁶⁶ The World Bank classifies financial systems into bank-based and market-based financial systems, based on a conglomerate index of financial structure. This index is based on measure of size, activity and efficiency. See details, Demirguc-Kunt and Levine (2001). In market-based financial systems such as the United States and United Kingdom, securities markets share center stage with banks in terms of getting society's saving to firms, exerting corporate control, and providing risk management tools. In this market system, as firms have various sources of fund, they show high elasticity of capital demand. However, in some circumstances – particularly involving inter-temporal risk sharing, market based systems will not do a good job. See Allen and Gale (2000).

on banks, the elasticity of capital demand is relatively low. For the countries with market-based financial systems such as the United States and United Kingdom, securities markets share center stage with banks in terms of getting society's saving to firms, exerting corporate control, and providing risk management tools. In this market system, as firms have various sources of fund, they show a high elasticity of capital demand.

Hence, the industrial countries with bank-based financial system such as Japan and Germany might be satisfied with this condition, e.g. see Table II for country classification in terms of income, financial market developments and types of financial market systems.

Corollary 1: A monopoly banking system has higher steady state level of capital stock than a monopolistically competitive banking system only if the degree of financial market developments is much lower (the cost of screening much higher) than the degree of capital intensity, i.e. $k_{MC} < k_M$ only if $\mu \ll \gamma$.

Proof. See Appendix C.11.

Corollary 1, arising from proposition 10 implies that a monopoly banking system has higher long-run equilibrium than a monopolistically competitive banking system only if the elasticity of capital demand is much higher than financial market development. As mentioned, industrial countries with market-based financial system such as United States and United Kingdom might satisfy this condition.

However, the condition $\gamma \gg \mu$ is a necessary condition, not sufficient.⁶⁷ The economic intuition for $\gamma \gg \mu$ to be a necessary condition is that even if the elasticity of capital demand is higher than the degree of financial markets development (lower thus screening cost), a competitive banking system might perform better in the case of lower information externalities.

The above analysis suggests that under the low information externality, a competitive banking system performs better when $\mu > \gamma$. However, if the elasticity of capital demand is much higher than financial markets development, a monopoly banking system might lead to higher capital accumulation. For industrial countries with market-based financial systems, hence, a monopoly banking system is good for leading to a higher steady state level of capital. This result may provide an explanation for the recent flurry mergers and acquisitions in the industrial countries.

⁶⁷ The sufficient condition is that the marginal cost in the monopoly banking system, MC_M is strictly lower than that in the competitive banking system, MC_{MC} . For example, even though the marginal revenue in the monopoly banking system is much higher than that in the competitive banking system, it is still possible that the intersection point in monopoly bank $k_M^{\gamma-1}$ is higher than that in monopolistically competitive bank $k_{MC}^{\gamma-1}$ if RHS_{MC} is strictly lower than RHS_M , i.e. $k_M^{\gamma-1} > k_{MC}^{\gamma-1}$. This means that the steady state level of capital in monopolistically competitive banking system is higher, i.e. $k_M^* < k_{MC}^*$ since $\gamma < 1$. But if RHS_M is strictly lower than RHS_{MC} , then $k_M^{\gamma-1} < k_{MC}^{\gamma-1}$ if the slope of $k_M^{\gamma-1}$ in LHS_M is steeper than that of $k_{MC}^{\gamma-1}$ in LHS_{MC} . This means that the steady state level of capital in monopoly banking system is higher, i.e. $k_M^* > k_{MC}^*$

5.2.2. High Information Externality

As mentioned, the degree of information externality has been recently increased substantially as information technology advances. This section analyzes long-run equilibrium under high information externality.

Proposition 11: In the case of high information externality ($\xi > \xi^*$), a monopoly banking system has a better performance in reaching a higher steady state level of capital than a competitive banking system if the proportion of high quality firms is low, i.e. $k_M > k_C$ if $\gamma > \Phi$.

Proof. See Appendix C.12.

Proposition 11 shows that if the proportion of high quality firms were relatively low, the loss in output associated with lending capital to lower quality firms would be high. Then the value added by screening activities would be large enough to compensate for the loss in output associated with the typical rent extraction activity of the monopoly. Note that a monopoly bank is engaged in screening, while competitive banks are not due to the free riding problem. Especially for the developing countries, hence, a monopoly banking system is better to accelerate economic growth.

Taking consideration of the condition of $\gamma > \Phi$, we can find that the countries with highly developed financial markets might satisfy the condition. Since firms in a highly developed financial market have various sources of funding, they show the high elasticity of capital demand. Hence, a monopoly banking system is more effective in promoting growth in a country with highly developed financial markets. This result

supports mergers and acquisition in the developing countries and regions having highly developed financial markets.

Corollary 2: In the case of high information externality, the competitive banking system has higher steady state level of capital than the monopoly banking system if the proportion of high quality firms is much higher than the elasticity of capital demand, i.e.

$$k_M < k_C \text{ only if } \Phi \gg \gamma.$$

Proof. See Appendix C.12.

Above corollary, arising from Proposition 11, implies that a competitive banking system might be better for countries with under-developed financial market such as ASEAN⁶⁸. ASEAN countries have recently grown so fast that the proportion of high quality firms has been increasing. However, the capital markets such as bonds and stocks markets are under-developed and they show relatively closed economies in that they have restraints on accessing international financial markets. They have suffered chronic excess capital demand, which implies that the elasticity of capital demand is low. These economies satisfy the condition that the proportion of high quality firms is much higher than the elasticity of capital demand.

⁶⁸ ASEAN (The Association of Southeast Asian Nations) was established at August 1967 in Bangkok by the five original Member Countries, namely, Indonesia, Malaysia, Philippines, Singapore, and Thailand. Brunei Darussalam joined at January 1984, Vietnam at July 1995, Laos and Myanmar at July 1997, and Cambodia at April 1999. The Objectives are: (i) to accelerate the economic growth, social progress and cultural development in the region through joint endeavors in the spirit of equality and partnership in order to strengthen the foundation for a prosperous and peaceful community of Southeast Asian nations, and (ii) to promote regional peace and stability through abiding respect for justice and the rule of law in the relationship among countries in the region and adherence to the principles of the United Nations Charter. See ASEAN Annual Report 2002-2003.

As in Corollary 1, however, the condition $\Phi \gg \gamma$ is a necessary condition, not sufficient. An economic intuition for $\Phi \gg \gamma$ to be necessary condition implies that a monopoly banking system performs better even if above condition holds. This suggests that in general a monopoly banking system is better under high information externality.

5.2.3. The Critical Level of Information Externality

To analyze the effect of information externality on comparative advantage of each market system, I define $\tilde{\xi}$ as a critical level of information externality, which equates the payoffs in the monopoly banking system to that in the competitive banking system.

Proposition 12: There exists a critical level of information externality, $\tilde{\xi}$ such that, for any $\alpha, \beta, \Phi, \gamma, \mu$ in their admissible ranges, $k_M(\tilde{\xi}) = k_C(\tilde{\xi})$ and $k_M(\xi) > k_C(\xi)$ for $\xi > \tilde{\xi}$ and $k_M(\xi) < k_C(\xi)$ for $\xi < \tilde{\xi}$ if and only if $\mu > \gamma > \Phi > 0$.

Proof. See Appendix C.13

Proposition 12 implies that as the information externality increases, a concentrated banking system may lead to a higher output for the economy. As seen in Proposition 3, competitive banks will retreat from engaging in screening activities as the degree of information externality increases. Hence, the allocative efficiency in the monopoly banking system dominates the loss in output associated with the rent extraction activities from monopoly banking system as the information externality increases.

As mentioned, advances in the financial infrastructure such as the credit evaluating system, networking and communication mean that it is easier for banks to access the information on firm's quality. Moreover, as banks disclose their financial statements more frequently and in a timely manner, the degree of information externality has been highly increased. This change implies that a monopolistic banking system has comparative advantage for promoting economic growth only if $\mu > \gamma > \Phi > 0$.

5.3 Comparative Statics

In previous section, I showed that under the assumption of low screening cost, monopolistic banking system is more effective to lead to higher steady state level of capital both in the developing countries and in the industrial countries. In this section, I perform comparative static. Comparative static analysis gives us insights for how the equilibrium condition varies as the other parameters of the economy change.

5.3.1. Low Information Externality

In the case of low information externality, we can compare equation (49) and (50) to perform comparative static. From Proposition 10 and Corollary 1, we know that the comparative advantage between the competitive banking system and the monopoly banking system may vary as the degree of financial market developments. Hence, let me

first look at the effect of the screening technology on competitive advantage of each market system.

5.3.1.1 Financial Markets Development μ

Let μ^* be a critical value of the level of financial market developments, which equates the steady state level of capital stock in the monopoly banking system to that in the competitive banking system.

Proposition 13: There exists a μ^* such that, for any $\alpha, \beta, \gamma, \mu$ in their admissible ranges, $k_M(\mu^*) = k_{MC}(\mu^*)$ and $k_M(\mu) > k_{MC}(\mu)$ for $\mu < \mu^*$ and $k_M(\mu) \leq k_{MC}(\mu)$ for $\mu > \mu^*$ if and only if $\gamma > \mu^* \in (0, 1)$.

Proof. See Appendix C.14

Proposition 13 implies that as the financial markets advance, the competitive banking system may produce a higher output in the case of lower information externality. Intuitively, competitive banks can easily access information on firm's quality without screening as financial markets advance. Then, the advantage of allocative efficiency in the monopoly banking system will be diminishing. Instead, the loss in output associated with typical rent extraction activities of a monopoly bank leads to inefficiency of economy. However, if the financial markets are under-developed, a monopoly bank has a competitive advantage in acquiring and processing information on firm's quality.

To explore the effect of changes in parameters on the relative advantage between monopolistic banking system and competitive banking system, let me define the difference function, Δ_1 as follows: $\Delta_1 = k_M - k_{MC}$. We know from Proposition 10 and Corollary 1 that $\Delta_1 > 0$ as $\gamma \geq \mu$ and $\Delta_2 < 0$ as $\gamma < \mu$. In order for the difference function, Δ_1 to be continuous function in μ , hence, $\gamma > \mu^*$ must be held. Let $k_1^* = k_M^{\gamma-1}(\mu^*) = k_{MC}^{\gamma-1}(\mu^*)$. Then, $\Delta_1(\mu^*, k_1^*, \alpha, \beta, \gamma, \Phi)$ can be rewritten by

$$(51) \quad \Delta_1(\mu^*, k_1^*, \alpha, \beta, \gamma, \Phi) = (\gamma - \mu^*)\gamma k_1^* - \left(\frac{1}{\beta}\right)^{\frac{1}{\alpha}} \left[\frac{\Phi(1-\gamma)k_1^* \left(\frac{1}{\alpha} - \mu^*\right) - \left(\frac{1}{\mu^*} - 1\right)}{(\Phi\mu^*(1-\gamma)k_1^* - 1)^{\frac{1}{\alpha}}} \right] = 0$$

5.3.1.2. The Effect of Φ on μ^*

Now let us explore that how the critical level of screening technology changes to be equating the steady state level of capital stock in both banking systems as the proportion of high quality firms increases. In other words, I investigate how μ^* varies as Φ changes, i.e. $\frac{\partial \mu^*}{\partial \Phi}$. As μ^* is not written explicitly as a function of Φ , I derive the effect

by applying the implicit function theorem on Δ_1 . That is,

$$(52) \quad \frac{\partial \mu^*}{\partial \Phi} = -\frac{\partial \Delta_1 / \partial \Phi}{\partial \Delta_1 / \partial \mu^*} = -\frac{\Delta_{1\Phi}}{\Delta_{1\mu^*}}$$

First, let me differentiate the difference function Δ_1 with respect to Φ , then

$$(53) \quad \frac{\partial \Delta_1}{\partial \Phi} = - \left(\frac{1}{\beta} \right)^{\frac{1}{\alpha}} \left[\frac{(1 - \frac{1}{\alpha}) \mu^* (1 - \gamma) k_1^* \left(\Phi (1 - \gamma) k_1^* \left(\frac{1}{\alpha} - \mu^* \right) + 1 \right)}{\{\Phi \mu (1 - \gamma) k_1^* - 1\}^{\frac{1+\alpha}{\alpha}}} \right]$$

The sign of $\frac{\partial \Delta_1}{\partial \Phi}$ is positive as $0 < \alpha < 1$. Recall that α denote the shape of saving supply schedule. For example, $\alpha = 1$ means horizontal supply schedule and $\alpha = 0$ means vertical supply schedule.⁶⁹ It is obvious, intuitively. If the saving supply is inelastic, the negative effect of rent extraction becomes smaller. In this case, the relative advantage of a monopoly bank is enlarged as the proportion of high quality firm increases.

Next, differentiating Δ_1 with respect to μ^* , we have

$$\frac{\partial \Delta_1}{\partial \mu^*} = -\gamma k_1^* - \left(\frac{1}{\beta} \right)^{\frac{1}{\alpha}} \left[\frac{-\Phi^2 (1 - \gamma)^2 \left(\mu^* + \frac{1}{\alpha} \left(\frac{1}{\alpha} - \mu^* \right) \right) k_1^{*2} + \Phi (1 - \gamma) \left(1 + \frac{1}{\mu^*} + \frac{1}{\alpha} \left(\frac{1}{\mu^*} - 1 \right) \right) k_1^* - \frac{1}{\mu^{*2}}}{\{\Phi \mu (1 - \gamma) k_1^* - 1\}^{\frac{1+\alpha}{\alpha}}} \right]$$

Let $C = \Phi (1 - \gamma) \left(\mu^* + \frac{1}{\alpha} \left(\frac{1}{\alpha} - \mu^* \right) \right)$ and $F = \Phi (1 - \gamma) \left(1 + \frac{1}{\mu^*} + \frac{1}{\alpha} \left(\frac{1}{\mu^*} - 1 \right) \right)$. Note that

$C > 0$ and $F > 0$. Then, above equation can be rewritten as

$$(54) \quad \frac{\partial \Delta_1}{\partial \mu^*} = -\gamma k_1^* - \left(\frac{1}{\beta} \right)^{\frac{1}{\alpha}} \left[\frac{-C \Phi (1 - \gamma) k_1^{*2} + F k_1^* - \frac{1}{\mu^{*2}}}{\{\Phi \mu (1 - \gamma) k_1^* - 1\}^{\frac{1+\alpha}{\alpha}}} \right].$$

⁶⁹ From equation (35), we can easily derive the elasticity of saving supply. Let $\varepsilon_{r,s} \equiv \frac{\partial s}{\partial r} \frac{r}{s}$. Then

$\varepsilon_{r,s} \equiv \frac{\alpha}{(1 - \alpha)} \frac{w - s}{s}$. Hence, $\varepsilon_{r,s} \rightarrow \infty$ as $\alpha \rightarrow 1$ and $\varepsilon_{r,s} \rightarrow 0$ as $\alpha \rightarrow 0$.

It is strictly negative if $\frac{F - \sqrt{F^2 - \frac{4C\Phi(1-\gamma)}{\mu^{*2}}}}{2C\Phi(1-\gamma)} < k^* < \frac{F + \sqrt{F^2 - \frac{4C\Phi(1-\gamma)}{\mu^{*2}}}}{2C\Phi(1-\gamma)}$. Intuitively,

it is obvious. As shown in the previous section, in the case of low information externality, the competitive advantage of monopolistic banking system is diminishing as the financial markets advance. This is consistent with historical evidences. For example, see e.g. Cetorelli (1997).

Hence, $\frac{\partial \mu^*}{\partial \Phi} > 0$ if $\frac{F - \sqrt{F^2 - \frac{4C\Phi(1-\gamma)}{\mu^{*2}}}}{2C\Phi(1-\gamma)} < k^* < \frac{F + \sqrt{F^2 - \frac{4C\Phi(1-\gamma)}{\mu^{*2}}}}{2C\Phi(1-\gamma)}$. That is,

the critical level of degree of financial markets development grows as the proportion of high quality firm increases in the case of low information externality. The economic meaning for a higher critical level of financial markets development is that an economy will benefit more from a monopoly banking system. It is due to over-investment of information system as all competitive banks are engaged in the screening activities. The excess demand for information on firms' quality causes inefficiency of the economy and this inefficiency dominates inefficiency associated with rent extraction behavior by a monopoly bank.

In the case of low information externality, hence, a monopoly banking system has better performance for reaching higher steady state level of capital as the proportion of high quality firms increases. It is the opposite result of previous literatures which conclude that a competitive banking system is better for the industrial countries.

5.3.1.3 The Effect of Degree of Capital Intensity, γ on μ^*

Now let us explore that how the critical level of financial markets development varies as the degree of capital intensity of technology γ changes. Note that the degree of capital intensity of technology can be interpreted by an indicator of the elasticity of capital demand. From this analysis, hence, I will answer the following question: Is a competitive banking system better for capital-intense countries (mainly industrial countries) or labor-intense countries (mainly developing countries)? Moreover, which banking system performs better if a country has a high (low) elasticity of capital demand?

To investigate how μ^* varies as γ changes, i.e. $\frac{\partial \mu^*}{\partial \gamma}$, I also apply the implicit function theorem on Δ_1 .

$$(55) \quad \frac{\partial \mu^*}{\partial \gamma} = - \frac{\partial \Delta_1 / \partial \gamma}{\partial \Delta_1 / \partial \mu^*} = - \frac{\Delta_{1\gamma}}{\Delta_{1\mu^*}}$$

Similarly, we can obtain the sign of equation (55).

$$(56) \quad \frac{\partial \Delta_1}{\partial \gamma} = (2\gamma - \mu^*)k_1^* - \left(\frac{1}{\beta}\right)^{\frac{1}{\alpha}} \left[\frac{(\frac{1}{\alpha} - \mu^*)\Phi k_1^* \{\Phi \mu^* (1 - \gamma)k_1^* (\frac{1}{\alpha} - 1) + 1\}}{\{\Phi \mu^* (1 - \gamma)k_1^* - 1\}^{\frac{1+\alpha}{\alpha}}} \right]$$

The sign of equation (56) is strictly negative if $\mu^* > 2\gamma$ ⁷⁰. This implies that the comparative advantage of the monopoly banking system will be diminishing as the

⁷⁰ If $\mu^* < 2\gamma$, the sign of equation (56) is ambiguous as first term of (56) shows positive, but second term shows negative.

economy has higher elasticity of capital demand. Intuitively, it is obvious. The negative repercussion on capital formation, associated with rent extraction activity in the monopolistic banking system, becomes worse as an economy has higher elasticity of capital demand. This result is consistent with historical evidence.

Let us look at the condition of $\mu^* > 2\gamma$ more carefully. The meaning of the extremely high critical value of the financial markets development implies that a monopoly banking system is more likely to lead to higher steady state level of capital stock. From equation (54), we know that $\Delta_{\mu^*} < 0$ if

$$\frac{F - \sqrt{F^2 - \frac{4C}{\mu^{*2}}}}{2C\Phi(1-\gamma)} < k^* < \frac{F + \sqrt{F^2 - \frac{4C}{\mu^{*2}}}}{2C\Phi(1-\gamma)}.$$

$$\text{Hence, } \frac{\partial \mu^*}{\partial \gamma} < 0 \text{ if } \mu^* > 2\gamma \text{ and } \frac{F - \sqrt{F^2 - \frac{4C}{\mu^{*2}}}}{2C\Phi(1-\gamma)} < k^* < \frac{F + \sqrt{F^2 - \frac{4C}{\mu^{*2}}}}{2C\Phi(1-\gamma)}. \text{ In other words,}$$

the critical level of the financial markets development decreases as the elasticity of capital demand increases. This means that economy benefits more from competitive banking system as the elasticity of capital demand increases. In general, countries with bank-based financial markets system such as Japan and Germany have a relatively low elasticity of capital demand than countries with market based financial markets system such as United States and United Kingdom. Hence, this result gives some empirical implications about whether the effect of a concentrated banking system on real economic activities will differ among countries with different financial markets system.

5.3.2. High Information Externality

In the case of high information externality, we can compare equation (48) and (50) to perform comparative static. From Proposition 11 and Corollary 2, we know that the comparative advantage between the competitive banking system and the monopoly banking system varies as the proportion of high quality firms in the economy changes. Firstly, let us look at the effect of the proportion of high quality firm on competitive advantage of each market system.

5.3.2.1 The Proportion of High Quality Firms, Φ

Let Φ^* be a critical value of the proportion of high quality firms, which equate the steady state level of capital stock in the monopoly banking system to that in the competitive banking system.

Proposition 14: There exists a Φ^* such that, for any $\alpha, \beta, \gamma, \mu$ in their admissible ranges, $k_M(\Phi^*) = k_C(\Phi^*)$ and $k_M(\Phi) > k_C(\Phi)$ for $\Phi < \Phi^*$ and $k_M(\Phi) \leq k_C(\Phi)$ for $\Phi > \Phi^*$ if and only if $\gamma < \Phi^* \in (0, 1)$.

Proof. See Appendix C.15

Proposition 14 implies that as the proportion of high quality firms increases, the competitive banking system may produce a higher output for the economy. Intuitively, the advantage of allocative efficiency in the monopoly banking system will be diminishing as high quality firm increases. In this case, the loss in output associated with

typical rent extraction activities of a monopoly bank dominates the advantage of allocative efficiency. This, in turn leads to inefficiency of economy.

To explore the effect of changes in parameters on the relative advantage between monopolistic banking system and competitive banking system, let me define the difference function, Δ_2 as follows: $\Delta_2 = k_M - k_C$. We know from Proposition 13 that $\Delta_2 > 0$ as $\gamma > \Phi$ and $\Delta_2 < 0$ as $\gamma < \Phi$. In order for the difference function, Δ_2 to be continuous function in Φ , hence, $\gamma < \Phi^*$ must be held. Let $k_2^* = k_M^{\gamma-1}(\Phi^*) = k_C^{\gamma-1}(\Phi^*)$. Then, $\Delta_2(\Phi^*, k_2^*, \alpha, \beta, \gamma, \mu)$ can be rewritten by

(57)

$$\Delta_2(\Phi^*, k_2^*, \alpha, \beta, \gamma, \mu) = (\gamma - \Phi^*)\gamma k_2^* - \left(\frac{1}{\beta}\right)^{\frac{1}{\alpha}} \left[\frac{\frac{\Phi^*(1-\gamma)}{\alpha} k_2^* - \mu^{-1}}{(\Phi^* \mu (1-\gamma) k_2^* - 1)^{\frac{1}{\alpha}}} - \frac{\Phi^{*2} (1-\gamma) k_2^* - 1}{(\Phi^{*2} (1-\gamma) k_2^* - 1)^{\frac{1}{\alpha}}} \right] = 0$$

5.3.2.2. The Effect of the Financial Markets Development, μ on Φ^*

Now let us explore that how the critical level of high quality firm's ratio changes to be equating the steady state level of capital stock in both banking system as the financial markets develop. In other words, I investigate how Φ^* varies as μ changes, i.e. $\frac{\partial \Phi^*}{\partial \mu}$.

As Φ^* is not written explicitly as a function of μ , I derive the effect by applying the implicit function theorem on Δ_2 . That is,

$$(58) \quad \frac{\partial \Phi^*}{\partial \mu} = -\frac{\partial \Delta_2 / \partial \mu}{\partial \Delta_2 / \partial \Phi^*} = -\frac{\Delta_{2\mu}}{\Delta_{2\Phi}}$$

First, let me differentiate the difference function Δ with respect to μ , then

$$(59) \quad \frac{\partial \Delta_2}{\partial \mu} = -\left(\frac{1}{\beta}\right)^{\frac{1}{\alpha}} \left[\frac{\Phi^*(1-\gamma)k_2^* \left(\frac{1}{\mu} - \frac{1}{\alpha} \left(\frac{\Phi^*(1-\gamma)k_2^*}{\alpha} - \frac{1}{\mu} \right) \right) - \frac{1}{\mu^2}}{\{\Phi^* \mu(1-\gamma)k_2^* - 1\}^{\frac{1+\alpha}{\alpha}}} \right]$$

Equation (59) is strictly positive if $k_2^* > \frac{\alpha(\alpha+1)}{\Phi^* \mu(1-\gamma)}$. Intuitively, it is apparent. The

allocative efficiency of a monopoly bank enlarges as screening technology advances.

Hence, the relative advantage of a monopoly banking system is positively correlated with the screening technology.

Next, let us differentiate Δ_2 with respect to Φ^* , we have

$$(60) \quad \begin{aligned} \frac{\partial \Delta_2}{\partial \Phi^*} &= -\gamma k_2^* - \left(\frac{1}{\beta}\right)^{\frac{1}{\alpha}} \left[\frac{\frac{(1-\gamma)k_2^*}{\alpha} \left(1 - \frac{1}{\alpha}\right) \Phi^* \mu(1-\gamma)k_2^*}{\{\Phi^* \mu(1-\gamma)k_2^* - 1\}^{\frac{1+\alpha}{\alpha}}} - \frac{\left(1 - \frac{1}{\alpha}\right) 2\Phi^*(1-\gamma)k_2^*}{\{\Phi^{*2}(1-\gamma)k_2^* - 1\}^{\frac{1}{\alpha}}} \right] \\ &= -\gamma k_2^* - \left(\frac{1}{\beta}\right)^{\frac{1}{\alpha}} \left(1 - \frac{1}{\alpha}\right) \Phi^*(1-\gamma)k_2^* \left[\frac{\frac{\mu}{\alpha} (1-\gamma)k_2^* \{\Phi^{*2}(1-\gamma)k_2^* - 1\}^{\frac{1}{\alpha}} - 2\{\Phi^* \mu(1-\gamma)k_2^* - 1\}^{\frac{1+\alpha}{\alpha}}}{\{\Phi^* \mu(1-\gamma)k_2^* - 1\}^{\frac{1+\alpha}{\alpha}} \{\Phi^{*2}(1-\gamma)k_2^* - 1\}^{\frac{1}{\alpha}}} \right] \end{aligned}$$

Equation (60) is strictly negative if $k_2^* > \frac{1}{\Phi^* \mu(1-\gamma)}$ ⁷¹. It is also obvious, intuitively. The

relative advantage of a monopoly banking system is diminishing as Φ increases.

Therefore, $\frac{\partial \Phi^*}{\partial \mu} > 0$ if $k_2^* > \max[\frac{1}{\Phi^* \mu(1-\gamma)}, \frac{\alpha(\alpha+1)}{\Phi^* \mu(1-\gamma)}]$. This result can be

interpreted that the critical level of high quality firm's ratio increases as the financial markets advance. The economic meaning for higher critical level of high quality firm's ratio is that the economy benefits more from a monopoly banking system. Hence, the monopoly banking system has a better performance in reaching higher steady state level of capital as the financial markets advances.

5.3.2.3 The Effect of the Elasticity of Capital Demand, γ on Φ^*

Now let us explore that how the critical level of high quality firm's ratio varies as the degree of capital intensity of technology, γ , changes. To investigate how Φ^* varies as

γ changes, i.e. $\frac{\partial \Phi^*}{\partial \gamma}$, I also apply the implicit function theorem on Δ_2 . Then,

$$(61) \quad \frac{\partial \Phi^*}{\partial \gamma} = - \frac{\partial \Delta_2 / \partial \gamma}{\partial \Delta_2 / \partial \Phi} = - \frac{\Delta_{2\gamma}}{\Delta_{2\Phi}}$$

Similarly, we can obtain the sign of equation (61).

⁷¹ Equation (60) is strictly negative if $\frac{\mu}{\alpha}(1-\gamma)k_2^*(\Phi^2(1-\gamma)-1)^{\frac{1}{\alpha}} < 2(\Phi\mu(1-\gamma)k_2^*-1)^{\frac{1+\alpha}{\alpha}}$

$$(62) \quad \frac{\partial \Delta_2}{\partial \gamma} = (2\gamma - \Phi^*)k_2^* - \left(\frac{1}{\beta}\right)^{\frac{1}{\alpha}} \left(\frac{1}{\alpha} - 1\right) \Phi^{*2} k_2^* \left[\frac{\frac{\mu}{\alpha}(1-\gamma)k_2^*}{\{\Phi^* \mu(1-\gamma)k_2^* - 1\}^{\frac{1+\alpha}{\alpha}}} - \frac{1}{\{\Phi^{*2}(1-\gamma)k_2^* - 1\}^{\frac{1}{\alpha}}} \right]$$

Note that Φ^* should be greater than γ , as seen in Proposition 11. The sign of equation (62) is ambiguous. However, a careful examination shows that all else equal, the sign of $\Delta_{2\gamma}$ is negative if $\Phi^* > 2\gamma$ and $k_2^* > \frac{1}{\Phi^* \mu(1-\gamma)}$. If $\gamma < \Phi^* < 2\gamma$ and $k_2^* < \frac{1}{\Phi^* \mu(1-\gamma)}$, the sign of equation (62) is strictly positive. Combined with equation (60) which shows strictly negative sign if $k_2^* > \frac{1}{\Phi^* \mu(1-\gamma)}$.

Hence, $\frac{\partial \Phi^*}{\partial \gamma} < 0$ if $\Phi^* > 2\gamma$ and $k_2^* > \frac{1}{\Phi^* \mu(1-\gamma)}$. Let us look at the condition of

$\Phi^* > 2\gamma$ more carefully. The meaning of the extremely high critical level of high quality firm's ratio implies that the monopolistic banking system has more likely to lead to higher steady state level of capital stock. Hence, we can conclude that the negative repercussion on capital formation, associated with rent extraction activity in the monopolistic banking system becomes worse as an economy has a higher elasticity of capital demand. This result is consistent with historical evidences.

As developing countries have low elasticity of capital demand, the monopolistic banking system is more effective to accelerate economic growth. However, the industrial countries have usually high elasticity of capital demand, their governments should take an additional measures such as setting guidelines on interest rates on deposits and loans to reduce negative effect of rent extraction activities of monopolistic banks.

Table X summarizes the result of comparative statics. In the case of a low degree of information externality, a monopoly banking system performs better as the proportion of high quality firms increases, however, competitive banking system is better as the elasticity of capital demand increases.

In the case of a high degree of information externality, a monopoly banking system has better performance as the financial markets advance.

Table X
Results of Comparative Statics

Information Externality	Focus	Comparative Static	Economic Meaning
Low ($\xi < \xi^*$)	μ^*	$\frac{\partial \mu^*}{\partial \Phi} > 0$	Monopoly banking system might be better as high quality firms increase - Over-Investment of Information System by the Competitive banking system
		$\frac{\partial \mu^*}{\partial \gamma} < 0$	Competitive banking system may be better as the elasticity of capital demand increases - Empirical Issues: Under-developed & Bank-based: Monopoly Developed & Market-based: Competitive
High ($\xi > \xi^*$)	Φ^*	$\frac{\partial \Phi^*}{\partial \mu} > 0$	Monopoly banking system is better as the financial markets advance - Lower Screening Cost
		$\frac{\partial \Phi^*}{\partial \gamma} < 0$	Competitive banking system is better as the elasticity of capital demand increases

6. POLICY IMPLICATIONS AND EXTENSIONS

The result of this paper suggests that there appears to be some relationship between economic development and market structure in banking industry. It also suggests that there is relationship between information externality and market structure.

In an early stage of economic development, both financial market development (μ) and the proportion of high quality firms (Φ) are likely to be low. However, they have high elasticity of capital demand as they have low capital demand. Hence, the following conditions, $\gamma > \mu$ and/or $\gamma > \Phi$ will be easily satisfied. Then, as shown in the Proposition 11 and Corollary 1, a monopolistic banking system might be more effective to achieve higher steady state level of capital and economic growth.

As economy advances, high quality firms increases. However, capital intensity of production function does not change much. Furthermore, if financial markets development falls behind economic growth, the chronic excess demand for capital will happen as shown in developing countries. In that case, a competitive banking system might be better.

However, as financial markets advance and information externality increases, a monopoly banking system regains its comparative advantage for promoting economy

The results of comparative static also show that a monopoly banking system has a comparative advantage as financial markets advance and the proportion of high quality firms increases. However, a competitive banking system has a comparative advantage as an economy shows a high elasticity of capital demand.

Above results give us empirical questions whether the effect of concentrated banking system on real economic activities will differ among countries with different financial systems and different economic conditions.

From Proposition 10, we can infer that if there is no information externality, the advantage of allocation efficiency in monopoly banking system washes away. Hence, in this case, a competitive banking system has a better performance regardless of the proportion of high quality firms in the economy. But even if there is low information externality, a monopoly banking system might have better performance if there is an inefficiency associated with the asymmetric information problem between banks and firms. Many relationship-oriented models suggest that the merit of a concentrated banking system is that it is more effective to overcome the asymmetric information problem.

As seen from empirical evidence, banks have made a huge investment on networking and computerization to respond to the strategic uncertainty. As keeping the information technology “in-house” is a way to keep future options open and diversify across possible areas of future focus⁷², a competitive banking system leads to overinvestment on information technology. Hence, a concentrated banking system through the mergers and acquisitions can be beneficial to the economy since it gives an economy of scale as well as the synergy effect from information sharing.

⁷² This argument comes from the theory developed by Boot et al (1998). In this context, the enormous premia that have been paid in M&A would be rationalized in part by the large projected savings in information technology expenses by the merging banks. See Thakor (1999)

This result holds under the high screening cost. For any countries whose economic development is relatively low and screening activities cost high, a monopolistic banking system is better to promote capital accumulation if the proportion of high quality firms is much lower. See Appendix B.

This paper should be considered as a first step in incorporating the level of economic development, financial markets development and information externality into the analysis of the effect of the banking market structure on the economic growth. Accordingly, there are a number of possible extensions.

First, in this model there is only a single good, there is no government sector, and banks are not regulated. Exploring the desirability of regulatory intervention, and allowing some scope for fiscal and monetary policy to affect the operation of the financial system would be important topics for further investigation. For example, in this paper, I assume that banks are owned by old agents. This assumption makes it simply to analyze. However, when we incorporate new agents, bank owner and bank regulator, into this model, we can analyze bank manager's incentive and policy implication of bank regulator.

Second, this paper analyzes the equilibrium law of motion for capital stock under different banking market structures. Exploring the transitional dynamics under different banking market structure would be interesting for future project, too.

Third, whereas this paper assumes that banks and firms are identical in size among themselves, it would be more realistic to introduce bank and firm size as a source of asymmetry into the model. Asymmetric bank and firm size gives the larger bank and

firm a higher degree of monopoly power at the occurrence of transaction, which in turn, influences strategic interaction among banks and/or among firms. Pecorino (2001) analyzes the effect of changes in industry structure on the ability to maintain a cooperative equilibrium in a repeated game setting. He allows size difference among firms and finds the following results. When the market share of the largest firm rises holding the size distribution of firms within the “fringe”, the changes in cooperation level among firms is not determined. However, when the number of identical firms in the fringe increases, cooperation becomes more difficult.

Another extension would be to introduce stochastic property of loan applicants. In other words, if lower quality firms happen to apply to one bank, and good quality firms apply to the other bank, how we reconcile the asymmetric property of loan applicants each bank faces? The results are likely to be sensitive to specific assumptions concerning information structure such as unilateral information asymmetry.

It is also interesting to model endogenous meager which depends on the degree of information externality. There is empirical evidence that the relationship between the number of banks and social welfare is an inverted U-shape. This implies that neither competitive banking system nor monopoly banking system are not pareto-dominant. Although the result in this paper suggests that it depends on information externality, it could be interesting if the number of banks gets to be chosen depending on the degree of information externality.

7. CONCLUSION

This paper explores the effect of banking market structure on capital accumulation. Specifically, it explores how the degree of information externality affects the bank's decision on screening activities. Based on that decision, the long-run equilibrium of capital stock in each banking system is derived. In addition, by comparing equilibrium under different banking systems, we find some relationships among economic development, financial market development, information externality and comparative advantage of a banking market structure.

While many theoretical studies on finance and growth have shown the importance of banks in fostering economic growth, little has been done in exploring the role played by the market structure of the banking industry. Moreover, little has investigated the relationship among information externality, financial markets development and market structure.

This paper shows that allocative efficiency due to screening activity is major factors for a monopolistic banking system to reach a better performance in accumulating capital. The efficient provision of screening technology is also a factor to give comparative advantage for monopoly banking system. This is consistent with empirical observations. The banking market structure affects both the overall quantity of credit available for investment purposes and the allocative efficiency of the credit market. In addition, it affects the investment decision on screening technology. If there is a perfect information externality, a competitive bank suffers allocative inefficiency, compared with a

monopoly bank. If there is no externality, competitive banks suffer investment inefficiency associated with under- and/or over-investment on screening technology.

Moreover, a monopolistic banking system might have better performance to lead to a higher capital per capita as information externality grows. That implies that a monopolistic banking system may be a “second best” for economic growth as information technology develops rapidly and, as consequence of it, the information externality grows swiftly.

This result can be applied to both developing countries and industrial countries. The developing countries usually have a lower stage of economic development, and a low proportion of high quality firms. The industrial countries usually have a high stage of economic development but high degree of information externality. Hence, a monopoly banking system might lead to a better performance in capital accumulation.

The results presented in this paper provide an alternative explanation for the recent deregulation and resulting trends in mergers and acquisitions in the industrial countries as well as in the developing countries. It also provides a theoretical foundation to support the policy change observed in different countries. In other words, this result supports that the government’s policy changes observed are appropriate in terms of growth.

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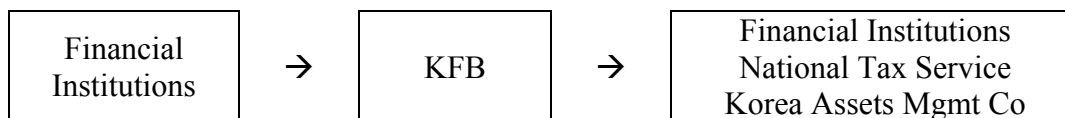
APPENDIX A

INFORMATION EXTERNALITY AND CONCENTRATION IN KOREA

1. Overview of Credit Management System in Korea

Korea established the Act on Utilization and Protection of Credit Information to manage credit risk and reduce the possibility of non-performing loans of financial institutions in 1995. In accordance to the Act, the Korea Federation of Banks (KFB) built the Credit Information Management Service (CIMS) to collect and distribute the credit information of individuals and firms. Financial institutions report credit information to KFB within 15 days from the occurrence of the transaction. All the information including the issuance of stocks and bonds and any changes in credit will be reported if the current credit balance of an individual exceeds 10 million Won (about US\$8,000 as of end of January 2003) and 100 million Won for a business (about US\$80,000).

- Foundation: Act on Utilization and Protection of Credit Information
- Objectives: To Reduce the Possibility of Non-Performing Loans
- Administrator: The Korea Federation of Banks
- Functions: Pooling and Administration of Credit Information
- Types and Contents of Credit Information:
 - . Type: Individuals, Firms, Non-financial Institutions
 - . Contents: borrower identification, credit delinquencies, credit transaction history, credit transaction capability
- Operation Process:



Individual: 10M won (US\$8,300)
 Firm: 100M won(US\$83,000)
 Within 15 days from transaction day

2. The Number of Financial Institutions in Korea

Korea suffered bank crises in the end of 1997. In the midst of rehabilitating the economy, mergers and acquisitions among the financial institutions were accelerated. For example, the number of banks decreased to 20 as of end of 2001, from 33 just before the crises. The number of life insurance companies and mutual savings and finances and credit unions reduced to 19, 122 and 1268 from 31, 231 and 1666, respectively. More surprisingly, the number of merchant banking corporations decreased 90% by 3 from 30. Unlike other financial institutions, the number of securities companies has increased to 46 from 36. This is attributed by capital market openness and liberalization. In addition, some of merchant banking corporations turned into securities companies. This shows how the crises change a market structure and lead to concentration.

	Number of Institutions at the end of 1997	1998-2001			Number of Institutions at the end of 2001
		Exit	Merger	New	
Banks	33	5	8	-	20
Merchant Banking Corporations	30	22	6	1	3
Securities Companies	36	6	1	17	46
Investment Trust Companies	31	6	1	6	30
Life Insurance Companies	31	7	5	-	19
Non-Life Insurance Companies	14	-	1	1	14
Mutual Savings & Finance	231	95	26	12	122
Credit Unions	1,666	305	102	9	1,268
Total	2,072	446	150	46	1,522

Source: Bank of Korea (2002)

3. Deterioration of Major Economic Indicators

The major economic indicators have deteriorated since 1995. The GDP growth rate drops by 5-6% from 7-8% per annum on average. More interestingly, the ratio of dishonored bills and debt ratio in manufacturing sector went up after establishment of credit sharing system. That might be explained partly by the problem of the information externality and because degree of concentration was not enough. As seen in the paper, as information externality grows, banks will not invest the efficient level of screening technology when the number of banks are large enough.. Contrary to the increase in debt ratio, the growth rate of gross fixed capital formation has dropped sharply on average.

In the midst of the restructuring process, Korean Government pushed forward some forms to reduce debt ratio below 200 percent and introduce a “Workout” system which makes distressed firms to be exited or funded easily. Those measures have been very effective to recover the economy.

Year	GDP Growth Rate	Ratio of Dishonored Bills	Gross Fixed Capital Growth Rate	Debt Ratio in Manufacture
1989	6.1	0.04	15.8	-
1990	9.0	0.04	25.9	285.52
1991	9.2	0.06	13.3	306.68
1992	5.4	0.12	-0.7	318.73
1993	5.5	0.12	6.3	294.88
1994	8.3	0.16	10.7	302.52
1995	8.9	0.17	11.9	286.75
1996	6.8	0.14	7.3	317.11
1997	5.0	0.40	-2.2	396.25
1998	-6.7	0.38	-21.2	303.02
1999	10.9	0.33	3.7	214.64
2000	9.3	0.26	11.4	210.57
2001	3.1	0.23	-1.8	182.20
2002p	6.3	0.06	4.8	135.44

Source: Bank of Korea (2002)

APPENDIX B

THE ASSUMPTION OF HIGH SCREENING COST: $\mu < \Phi$

In this appendix, I show how the results change as the cost of screening increases. In other words, how are the results affected when the screening cost is too high to compensate investment loss, i.e $(1 - \mu) > (1 - \Phi)$.

First of all, notice that the no screening equilibrium performs better than the screening equilibrium in the competitive market if $\Phi > \mu$. This can be shown in a straight forward way. Figure 3 shows self evident. The vertical asymptote for marginal cost in the competitive bank with screening, expressed in equation (49), MC_{MC} is strictly higher than that in the competitive bank with no screening, expressed in equation (48), MC_C . Hence, every point of RHS_{MC} is strictly to the right of RHS_C . If $\Phi > \mu$, the slope of $k_{MC}^{\gamma-1}$ in marginal revenue of equation (49), MR_{MC} is flatter than that of $k_C^{\gamma-1}$ in equation (48), MR_C , which implies that $k_{MC}^{\gamma-1} > k_C^{\gamma-1}$. Note that as $\gamma < 1$, so $k_C > k_{MC}$. Intuitively, as screening activities are not value added any longer, no screening equilibrium (perfect information externality case) has higher steady state level of capital than screening equilibrium (no information externality). But this results is not consistent with the conventional wisdom that externality leads to inefficiency. The conventional wisdom suggests that if there is information externality, screening equilibrium has better performance than no screening equilibrium. Therefore, the assumption that screening cost is less than investment loss is reasonable as I mentioned.

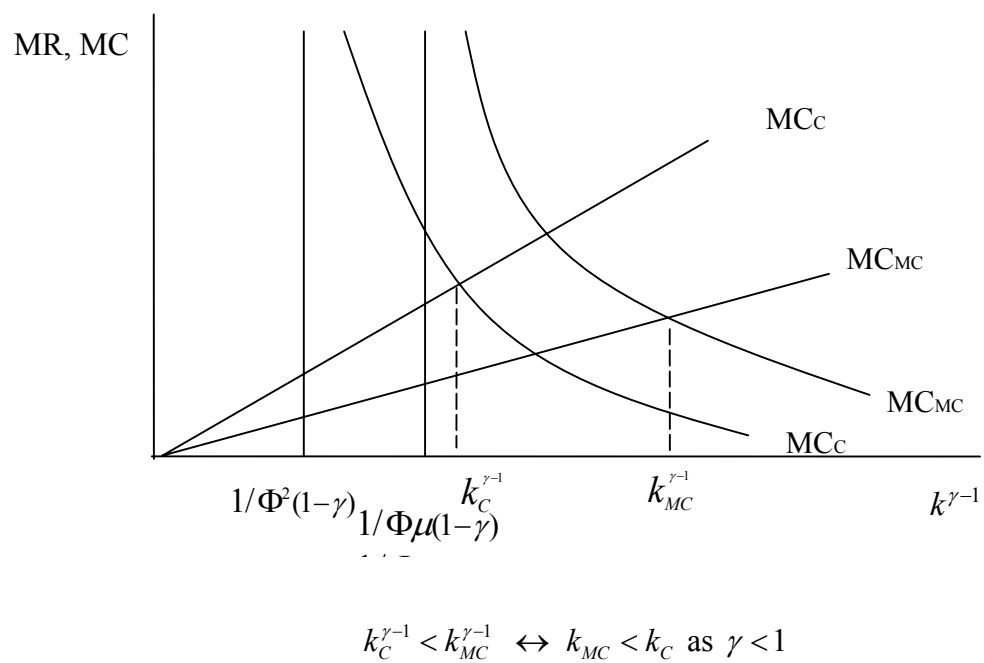
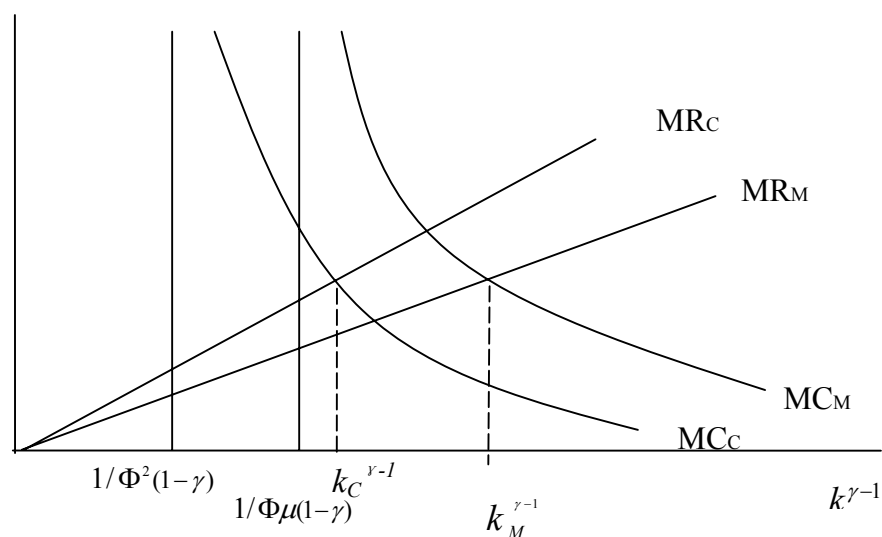


FIGURE 3.-Equilibrium Level of Capital - Competitive Banking System with Information Externality if $\Phi > \mu$

Second, the competitive banking system reaches higher steady state level of capital if $\mu < \Phi$. This is reverse to Proposition 11 and Corollary 2. Figure 4 shows this relationship graphically. The vertical asymptote for marginal cost in the competitive bank, expressed in equation (48), MC_C is strictly lower than that in the monopoly bank, expressed in equation (50), MC_M . Therefore, every point of MC_C is strictly to the left of MC_M . If $\Phi > \gamma$, then the slope of $k_M^{\gamma-1}$ in left-hand side of equation (50), MR_M is flatter than that of $k_C^{\gamma-1}$ in left-hand side of equation (48), MR_C , which implies that $k_M^{\gamma-1} > k_C^{\gamma-1}$. Note that as $\gamma < 1$, so $k_M < k_C$.

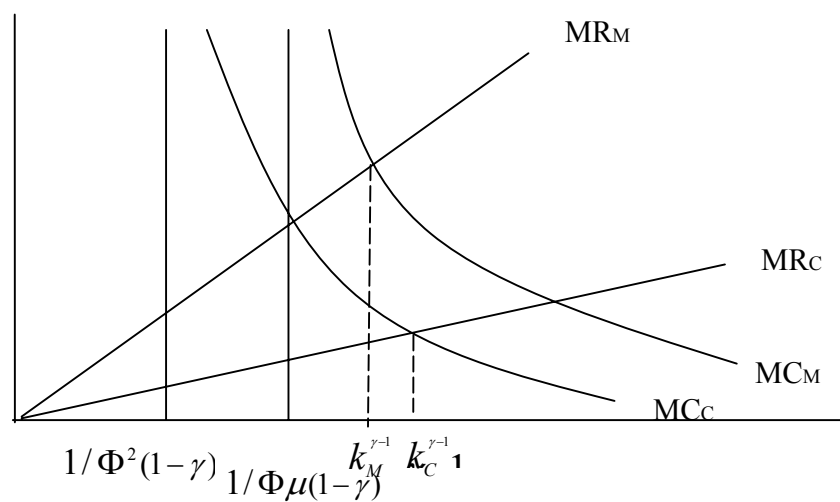
If $\gamma \gg \Phi$, then the slope of $k_M^{\gamma-1}$ in left-hand side (MR_M) is much steeper than that of $k_C^{\gamma-1}$ in left-hand side (MR_C), which might lead to the conclusion of $k_M^{\gamma-1} < k_C^{\gamma-1}$. This implies $k_M > k_C$ as $\gamma < 1$. The competitive banking system has a better performance because the allocative advantage of monopoly bank will disappear. This can be interpreted in a different way. If the proportion of high quality firms is high and screening activities do not give any economic benefit, then no banks have incentive to screen. But if the proportion of high quality firm is much lower, as seen in developing countries, screening activities may make the value added although screening costs very large. In the case of low proportion of high quality firms, a monopoly banking system may have a better performance. This result is consistent with Cetorelli's (1997): he suggests that for the developing countries, a monopolistic bank may have a better performance.

Case 1: $\Phi > \gamma$



$$k_M^{\gamma-1} > k_C^{\gamma-1} \Leftrightarrow k_M < k_C \text{ since } \gamma < 1$$

Case 2: $\gamma > \Phi$



$$k_M^{\gamma-1} < k_C^{\gamma-1} \Leftrightarrow k_C < k_M \text{ since } \gamma < 1$$

FIGURE 4.-Equilibrium Level of Capital – Monopoly and Competitive Banking System with High Screening Cost

APPENDIX C

PROOFS

Proposition 1: Aggregate Credit and Capital

First, I will show $X_t^N > X_t^R > X_t^S$.

If no banks screen, the total saving from old agents becomes loans supplied to firms, i.e. $X_t^N = S_t$. However, if all banks screen, because of the screening cost, the total credit available credit will be $N(s_t^j - b) = \mu N s_t^j = \mu S_t = X_t^S$. Therefore $X_t^N = S_t > \mu S_t = X_t^S$ as $0 < \mu < 1$. When the probability of screening is considered, the total available credit is

$$(C.1) \quad X_t^R = q_t X_t^S + (1 - q_t) X_t^N = q_t \mu S_t + (1 - q_t) S_t = [1 - q_t(1 - \mu)] S_t < S_t = X_t^N$$

since the fraction of firms that are screened, $q_t \in [0, 1]$. To compare the size of X_t^R , X_t^S , we obtain the difference of both coefficients.

$$(C.2) \quad X_t^R - X_t^S = [(1 - q_t + q_t \mu) - \mu] S_t = (1 - \mu)(1 - q_t) S_t > 0 \text{ since } 0 < \mu < 1 \text{ \& } 0 < q_t < 1.$$

Hence, $X_t^N > X_t^R > X_t^S$

Next, I will show $x_t^N < x_t^R < x_t^S$ or $x_t^N < x_t^S < x_t^R$.

To compare the size of credit for an individual firm, we need the number of firms that receive credit. If there is no screening, all the firms are credit recipients. With mass unit of entrepreneurs, $x_t^N = X_t^N = S_t$. If all banks screen, only high quality firms (Φ) have

access to credit. Hence, $x_t^S = \frac{X_t^S}{\Phi} = \frac{\mu}{\Phi} S_t > S_t = x_t^N$ since $\mu > \Phi$ by definition. When

randomizing with probability q_t , the number of firms that have access to credit is

$(1 - q_t) + q_t \Phi = 1 - q_t(1 - \Phi)$. Therefore, the expected credit for an individual firm, x_t^R is

$$(C.3) \quad x_t^R = \left(\frac{(1 - q_t)(1 - \mu)}{1 - q_t(1 - \Phi)} \right) S_t > S_t = x_t^N$$

since $\mu > \Phi$ by assumption.

To compare the size of x_t^S and x_t^R , we obtain the difference of both coefficients,

$$(C.4) \quad x_t^S - x_t^R = \left(\frac{\mu}{\Phi} - \frac{1 - q_t(1 - \mu)}{1 - q_t(1 - \Phi)} \right) S_t = \left(\frac{(\mu - \Phi)(1 - q_t)}{\Phi[1 - q_t(1 - \Phi)]} \right) S_t > 0$$

since $\mu > \Phi$ by assumption. Hence, $x_t^N < x_t^R < x_t^S$.

Proposition 2: Critical Degree of Information Externality

The proof is straightforward. By comparing the screening cost (if banks screen) and the opportunity cost (if banks do not screen), we can derive the critical level of information externality.

The screening cost is

$$(C.5) \quad (1 - \mu)s_t^j.$$

The opportunity cost of not screening firms is

$$(C.6) \quad \begin{aligned} & \{\text{Pr } ob(H) * \text{Pr } ob(\tilde{\eta} = \tilde{L} / H) + \text{Pr } ob(L) * \text{Pr } ob(\tilde{\eta} = \tilde{H} / L)\} s_t^j \\ & = \left\{ \Phi \left(\frac{1 - \xi}{2} \right) + (1 - \Phi) \left(\frac{1 - \xi}{2} \right) \right\} s_t^j \end{aligned}$$

Let ξ^* be the critical level of information externality which equates the screening cost and opportunity cost. Equate above opportunity cost to $(1-\mu)s_t^j$ and solve for ξ^* ,

$$(C.7) \quad \xi^* = 2\mu - 1$$

The above relationship implies that if we have highly efficient screening technology, i.e. $\mu \rightarrow 1$, we should have perfect information externality to be equated the payoffs of screening equilibrium and no-screening equilibrium. In other words, if we have higher screening technology, banks are more likely to have higher payoffs when they are engaged in screening activities. In addition, as $0 \leq \xi \leq 1$, $1/2 \leq \mu \leq 1$. It means that the aggregate amount of screening cost should not exceed a half of total lending amount.

If $\xi > \xi^* = 2\mu - 1$, then the opportunity cost of no screening is less than screening cost. Therefore, banks will decide not to screen. Similarly, if $\xi < \xi^* = 2\mu - 1$, banks will decide to screen since screening gives more payoffs.

Proposition 3: No Screening Equilibrium

First, I will show that $z_j^* = NS$ for every $j=1,2,...,N$ is an equilibrium.

If all banks choose {No Screening}, the total revenue will be $\Phi R_{t+1}^L S_t$ as discussed.

Given the zero-profit condition, we can derive deposit interest rate r_{t+1} , which is ΦR_{t+1}^L .

Suppose that a bank j deviates and decides to screen. Since the information about screened high quality firms becomes public immediately, all “outside” banks make a

better offer to the entrepreneurs. Therefore, a screening bank j suffers a loss, i.e. $\pi_j < 0$. There, thus, is no incentive for any banks to deviate from the optimal strategy, i.e. $z_j = NS$ for every $j=1,2,\dots,N$. Therefore, $z_j^* = NS$ is an equilibrium.

Next, I will show $z_j^* = NS$ is unique equilibrium. Suppose $z_{j'} \neq NS$ is an equilibrium. Then, a bank $j \in j'$ will be subject to free riding and will suffer a net loss as shown above. If this bank decides to deviate and choose NS, it will benefit from free riding and will make at least zero profits. Therefore, $z_{j'} \neq NS$ is not an equilibrium.

Proposition 4: Screening Equilibrium

First, I will show that $z_j^* = S$ is an equilibrium.

If all banks choose to screen, the total revenue will be $\mu R_{t+1}^L S_t$, which is greater than the payoffs of no screening, $\Phi R_{t+1}^L S_t$. Given the zero-profit condition, the deposit interest rate r_{t+1} is μR_{t+1}^L if screened, and ΦR_{t+1}^L if not. Suppose that a bank j deviates and decides not to screen. Then the bank j 's deposit interest rate will be lower than other banks'. As depositors seek for higher deposit rates, a bank j will exit in the market. There, thus, is no incentive to deviate from the optimal strategy $z_j = S$. Therefore, $z_j^* = S$ is an equilibrium for every $j=1,2,\dots,N$.

Next, I show $z_j^* = S$ is a unique equilibrium. Suppose that $z_{j'} \neq S$ is an equilibrium. Then, a bank $j \in j'$ will exit from this market. If this bank decides to deviate and choose S , it will make at least zero profits. Therefore, $z_{j'} \neq S$ is not an equilibrium.

Proposition 5: Payoffs Comparison

First, I will show $\Pi_2 > \Pi_1$. In the case of Π_2 (No Screening, Screening), bank i does not screen, but he can recognize high quality firms because another bank screens the firms and the information about the quality of firms are publicized immediately. Hence, bank i can use his all available fund to lend to only screened high quality firms. In the case of Π_1 (Screening, Screening), bank i can recognize high quality firms with cost of screening. Therefore, the amount of loan is less than that in case Π_2 . Therefore, $\Pi_2 > \Pi_1$.

Next, I will show $\Pi_4 > \Pi_3$. In the case of Π_4 (No Screening, No Screening), bank i lends to all firms indiscriminately. Hence, he can recover Φs_t^i . However, in the case of Π_3 (Screening, No Screening), bank i does screen and distinguish high quality firms but bank j lends to screened high quality firm. Instead, bank i lends to both high and low quality firms indiscriminately. Hence he can recover $\Phi \mu s_t^i$. Hence, $\Pi_4 > \Pi_3$. By assumption, we know that $\Pi_1 > \Pi_4$. Therefore $\Pi_2 > \Pi_1 > \Pi_4 > \Pi_3$ holds.

Proposition 6: No Screening Equilibrium

It is straightforward. From Table XI, we can easily find the best response for bank i is {No screening} regardless of bank j 's strategies, and vice versa. $BR_i = N$ & $BR_j = N$, Hence, Nash equilibrium is no bank screens, i.e. (NS, NS)

Table XI shows the payoff of bank i, j given their own stage one strategy. If both banks screen, the payoffs of both banks Π_1 , If bank1 (bank2) screens but bank2 (bank1) does not screen, bank2 (bank1) benefit from information externality. Then, the payoffs of bank1 (bank2) and bank2 (bank1) are Π_3, Π_2 respectively. However, if both banks do not screen, their payoffs are same to Π_4 .

Table XI

Payoffs of Banks

		Bank 2	
		Screen (S)	No Screen (N)
Bank 1	Screen (S)	Π_1, Π_1	Π_3, Π_2
	No Screen (N)	Π_2, Π_3	Π_4, Π_4

Proposition 7: Screening Equilibrium

It is straightforward. From Table XII, we can easily find the best response for bank i is {Screening} regardless of bank j 's strategies, and vice versa. $BR_i = S \& BR_j = S$, Hence, Nash equilibrium is no bank screens, i.e. (S, S)

Table XII shows the payoff of bank i, j given their own stage one strategy. If a bank screens, the payoffs of the bank is Π_1 , while a bank does not screen, the payoffs is Π_4 . As Π_1 is greater than Π_4 , a bank's best strategy is screening.

Table XII

Payoffs of Banks

		Bank 2	
		Screen (S)	No Screen (N)
Bank 1	Screen (S)	Π_1, Π_1	Π_1, Π_4
	No Screen (N)	Π_4, Π_1	Π_4, Π_4

FOC of profit maximization problem for monopoly

$$(C.8) \quad \text{Objective function: } \mu R_{t+1}^L s_t - r_{t+1}^M s_t$$

$$\text{Subject to: } R_{t+1}^L = \gamma k_{t+1}^{\gamma-1}$$

$$r_{t+1}^M = \left(\frac{1}{\beta}\right)^{\frac{1}{\alpha}} \left[\frac{\omega_t - s_t}{s_t}\right]^{\frac{\alpha-1}{\alpha}}$$

$$w_{t+1} = (1-\gamma)k_{t+1}^{\gamma}$$

$$k_{t+1} = \Phi \mu s_t$$

Plugging constraints into objective function,

$$(C.9) \quad \mathbf{Max}_{\{k_{t+1}\}} \Phi^{-1} \gamma k_{t+1}^{\gamma} - \left(\frac{1}{\beta}\right)^{\frac{1}{\alpha}} [\Phi \mu (1-\gamma) k_t^{\gamma} k_{t+1}^{-1} - 1]^{\frac{\alpha-1}{\alpha}} (\Phi \mu)^{-1} k_{t+1}$$

Differentiating with respect to k_{t+1} ,

$$(C.10) \quad \frac{\partial \pi}{\partial k_{t+1}} = \Phi^{-1} \gamma^2 k_{t+1}^{\gamma-1} - \left(\frac{1}{\beta}\right)^{\frac{1}{\alpha}} \Phi^{-1} \mu^{-1} [\Phi \mu (1-\gamma) k_t^{\gamma} k_{t+1}^{-1} - 1]^{\frac{\alpha-1}{\alpha}} \\ - \left(\frac{1}{\beta}\right)^{\frac{1}{\alpha}} \Phi^{-1} \mu^{-1} k_{t+1} \left(\frac{\alpha-1}{\alpha}\right) [\Phi \mu (1-\gamma) k_t^{\gamma} k_{t+1}^{-1} - 1]^{\frac{-1}{\alpha}} [-\Phi \mu (1-\gamma) k_t^{\gamma} k_{t+1}^{-2}] = 0$$

By rearranging terms,

$$(C.11) \quad \gamma^2 k_{t+1}^{\gamma-1} - \left(\frac{1}{\beta}\right)^{\frac{1}{\alpha}} \left[\frac{\Phi(1-\gamma)}{\alpha} k_t^{\gamma} k_{t+1}^{-1} - \mu^{-1}\right] [\Phi \mu (1-\gamma) k_t^{\gamma} k_{t+1}^{-1} - 1]^{\frac{-1}{\alpha}} = 0$$

Hence,

$$(C.12) \quad \gamma^2 k_{t+1}^{\gamma-1} - \left(\frac{1}{\beta}\right)^{\frac{1}{\alpha}} \left\{ \frac{\left[\frac{\Phi(1-\gamma)}{\alpha} k_{t+1}^{-1} k_t^{\gamma} - \mu^{-1}\right]}{[\Phi \mu (1-\gamma) k_{t+1}^{-1} k_t^{\gamma} - 1]^{\frac{1}{\alpha}}} \right\} = 0$$

Proposition 8: Unique Steady State Level of Capital

The left-hand side of equation (48), (49) and (50) are linearly increasing in $k_C^{\gamma-1}$, $k_{MC}^{\gamma-1}$ and $k_M^{\gamma-1}$, respectively. The right-hand side of (48), (49) and (50) have a vertical asymptote for $k_C^{\gamma-1} = \frac{1}{\Phi^2(1-\gamma)}$, $k_{MC}^{\gamma-1} = \frac{1}{\mu\Phi(1-\gamma)}$ and $k_M^{\gamma-1} = \frac{1}{\mu\Phi(1-\gamma)}$, respectively. And those are converging to zero as $k_C^{\gamma-1} \rightarrow \infty$, $k_{MC}^{\gamma-1} \rightarrow \infty$, $k_M^{\gamma-1} \rightarrow \infty$, respectively. Thus, in all cases, there is unique long run equilibrium, k_C , k_{MC} and k_M .

Proposition 9: $k_C < k_{MC}$ As ξ Increases

Figure 5 depicts the steady state level of capital in competitive market with high information externality ($\xi > \xi^*$) and with low information externality ($\xi < \xi^*$). Note that screening cost is assumed to be less than investment loss from lending to lower quality firms, i.e. $\mu > \Phi$. Therefore, the vertical asymptote for the marginal cost in the competitive bank with low information externality (MC_{MC}) is strictly lower than that with high information externality (MC_C). Hence, every point of MC_C is strictly to the right of MC_{MC} . Note that $\mu > \Phi$ by assumption. Therefore, the slope of $k_{MC}^{\gamma-1}$ in left-hand side (MR_{MC}) is steeper than that of $k_C^{\gamma-1}$ in left-hand side (MR_C), which implies $k_{MC}^{\gamma-1} < k_C^{\gamma-1}$. Note that as $\gamma < 1$, $k_C < k_{MC}$.

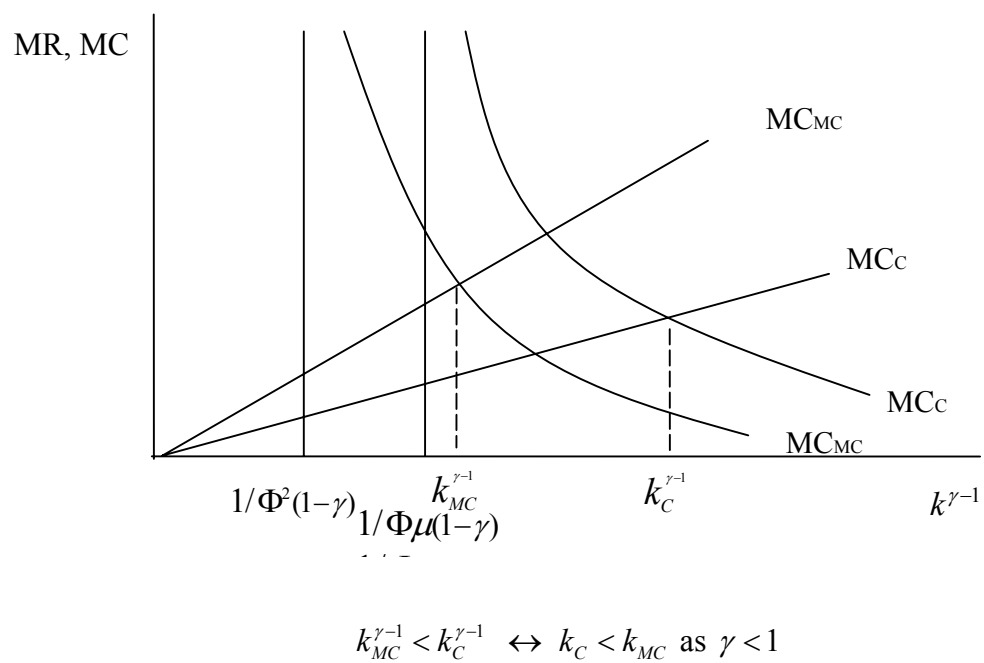
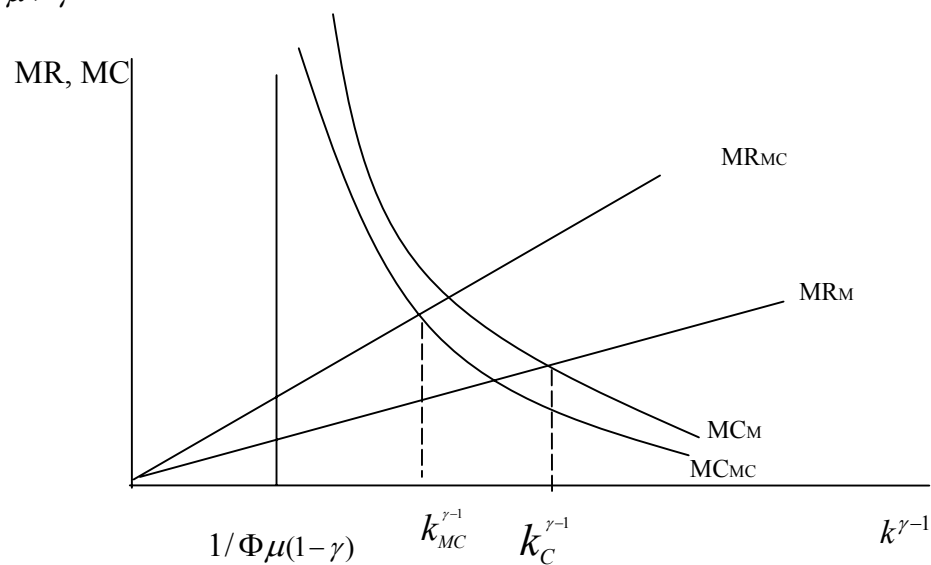


FIGURE 5.-Equilibrium Level of Capital - Competitive Banking System with Information Externality

Proposition 10 and Corollary 1: $k_C < k_{MC}$ if $\mu > \gamma$

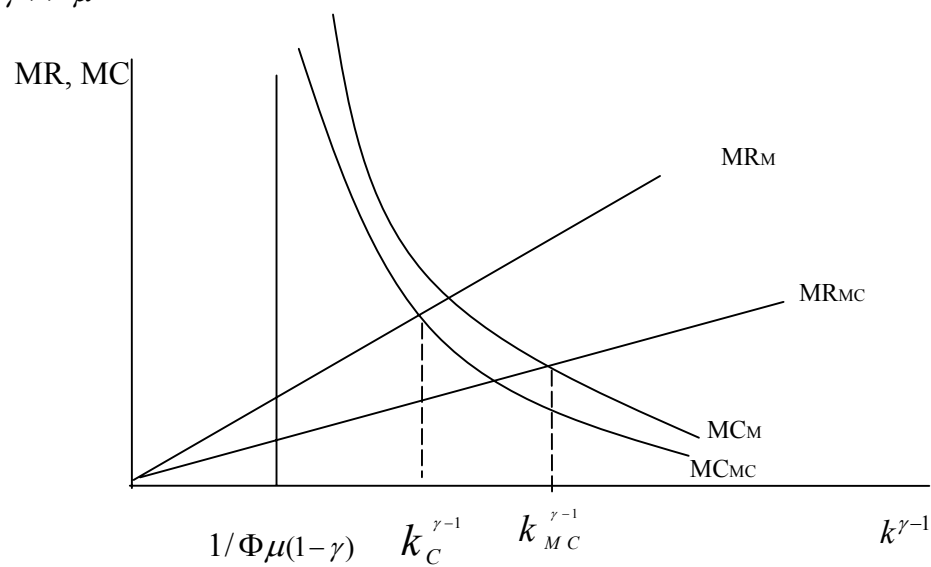
Figure 6 depicts the relationship between the steady state level of capital in competitive market and that in monopoly market if there is no information externality. From equation (49) and (50), we know that the vertical asymptote for the right hand side are same in both cases, say $\frac{1}{\mu\Phi(1-\gamma)}$. But coefficient of $k^{\gamma-1}$ in numerator of monopoly bank, $\frac{\Phi(1-\gamma)}{\alpha}$ is greater than that of monopolistically competitive bank, $\mu\Phi(1-\gamma)$ as $\frac{1}{\alpha} > \mu$. Therefore, MC_{MC} is strictly lower than MC_M . Hence, every point of MC_M is strictly to the right of MC_{MC} . If $\mu > \gamma$, the slope of $k_{MC}^{\gamma-1}$ in left-hand side (MR_{MC}) is steeper than that of $k_M^{\gamma-1}$ in left-hand side (MR_M), which implies that $k_{MC}^{\gamma-1} < k_M^{\gamma-1}$. Note that since $\gamma < 1$, $k_M < k_{MC}$. However, if $\gamma > \mu$, then the slope of $k_M^{\gamma-1}$ in left-hand side, MR_M , is much steeper than that of $k_{MC}^{\gamma-1}$ in MR_{MC} , which may obtain the result that $k_M^{\gamma-1} < k_{MC}^{\gamma-1}$. Note that since $\gamma < 1$, $k_M > k_{MC}$.

Case 1: $\mu > \gamma$



$$k_{MC}^{\gamma-1} < k_M^{\gamma-1} \Leftrightarrow k_M < k_{MC} \text{ since } \gamma < 1$$

Case 2: $\gamma \gg \mu$



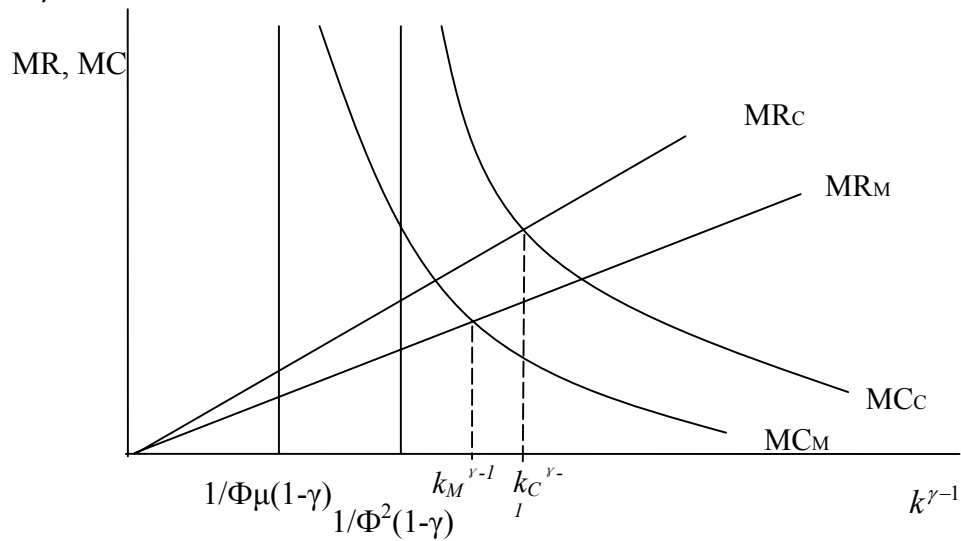
$$k_M^{\gamma-1} < k_{MC}^{\gamma-1} \Leftrightarrow k_{MC} < k_M \text{ since } \gamma < 1$$

FIGURE 6.-Equilibrium Level of Capital – Monopoly and Competitive Banking System with Low Information Externality

Proposition 11 and Corollary 2: $k_M > k_C$ if $\gamma > \Phi$

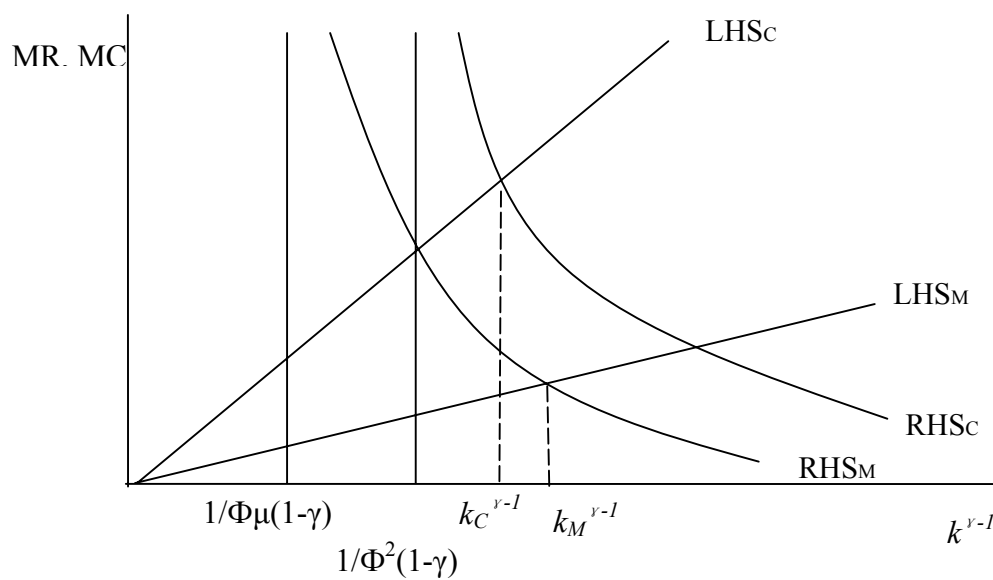
It is straightforward. Figure 7 shows self evident for Proposition 11 and Corollary 2. From (48) and (50) we know that the vertical asymptote for the right hand side in the competitive bank (MC_C) is strictly higher than that in the monopoly bank (MC_M). Therefore, every point of MC_C is strictly to the right of MC_M . If $\gamma > \Phi$, then the slope of $k_M^{\gamma-1}$ in left-hand side (MR_M) is steeper than that of $k_C^{\gamma-1}$ in left-hand side (MR_C), which implies that $k_M^{\gamma-1} < k_C^{\gamma-1}$. Note that as $\gamma < 1$, so $k_M > k_C$. However, if $\Phi \gg \gamma$, then the slope of $k_C^{\gamma-1}$ in left-hand side, MR_C , is much steeper than that of $k_M^{\gamma-1}$ in MR_M , which may obtain the result that $k_C^{\gamma-1} < k_M^{\gamma-1}$. Note that as $\gamma < 1$, so $k_M < k_C$.

Case 1: $\gamma > \Phi$



$$k_M^{\gamma-1} < k_C^{\gamma-1} \leftrightarrow k_C < k_M \text{ since } \gamma < 1$$

Case 2: $\gamma < \Phi$



$$k_M^{\gamma-1} > k_C^{\gamma-1} \leftrightarrow k_C > k_M \text{ since } \gamma < 1$$

FIGURE 7.-Equilibrium Level of Capital – Monopoly and Competitive Banking System with High Information Externality

Proposition 12

From Proposition 10, we know that under low information externality, $k_M < k_C$ if $\mu > \gamma$, for any value of the remaining parameters. However, from Proposition 11, we know that under high information externality, $k_M > k_C$ if $\gamma > \Phi$ for any value of the remaining parameters. Therefore, in order for $k_M = k_C$ to hold, it must be that $\xi^* \in (0,1)$. And if $\xi > \xi^*$, $k_M > k_C$ and vice verse.

VITA

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